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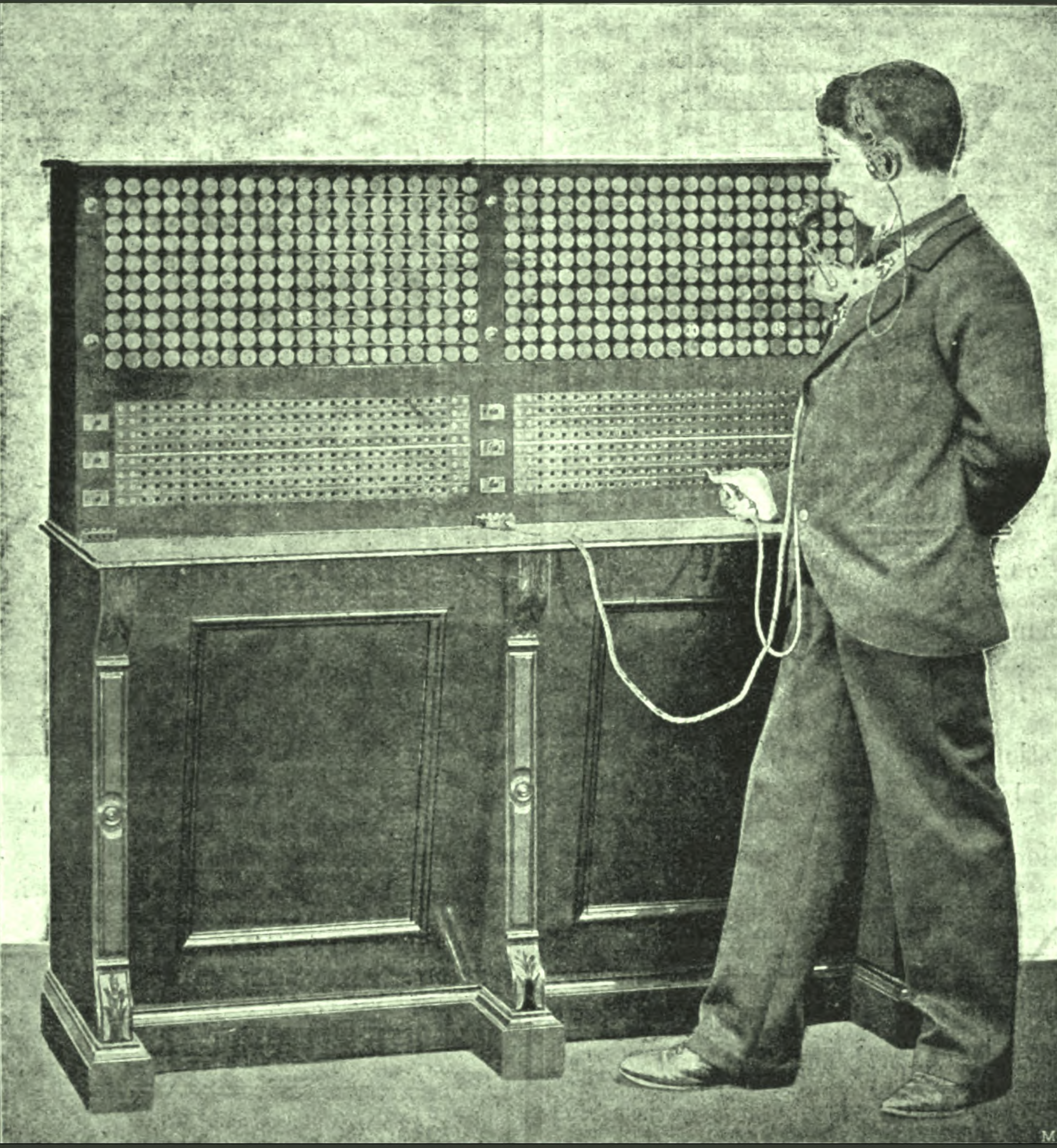

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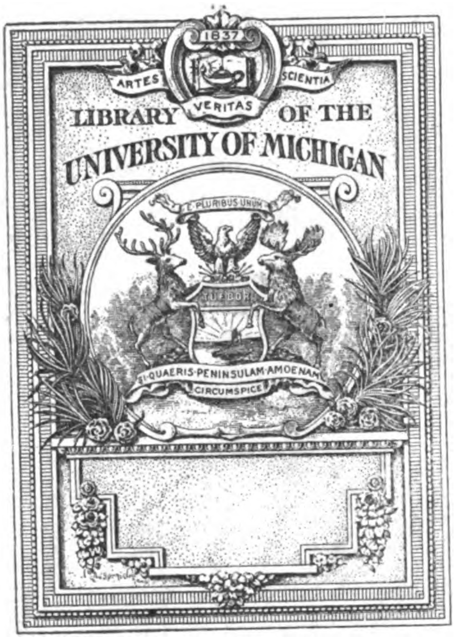

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THE

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NOTES.

Elektrotechnischer Verein.—The *Zeitschrift für Elektrotechnik* for June opens with an obituary note in reference to the recent death of the Archduke Charles Louis of Austria, who was patron of the Vienna Electrical Engineering Society.

South Kensington Museum.—The Lords of the Committee of Council on Education have appointed Mr. C. Purdon Clarke, C.I.E., F.S.A., director of the South Kensington Museum in succession to the late Dr. Middleton. Mr. A. B. Skinner, B.A., succeeds Mr. Purdon Clarke as assistant director.

A Breakdown.—According to the local Press, there was a temporary breakdown at the Cardiff generating station on Saturday last, so that "the principal streets of the town were suddenly plunged into semi-darkness. The accident occurred about 10 o'clock, and it took 20 minutes to remedy the defect." Evidently not a very serious affair.

Lundy Island Cable.—The cable to Lundy Island, which has not been working for about a fortnight, was repaired on Tuesday last and communication re-established. The fault was about three miles out from Croyde, and it is stated that some trouble was experienced in remedying the defect, owing to the heavy sea and high wind in the channel.

New Technical Paper.—We have received from Milan the first number of *L'Illuminazione*, a new monthly which is to be devoted to matters connected with lighting, whether by electricity, gas on the ordinary or the incandescent system, or oil. In the present number a large amount of space is devoted to the subject of acetylene. The paper is issued from Via Dante, 6, Milan.

Dublin Tramways.—We announced last week that the electric tramway had been purchased by the Dublin United Tramway Company. On the 28th ult. they managed somehow to break the overhead line at Kingstown, but nothing more serious happened than the temporary stoppage of the traffic until matters could be rearranged so as to run the traffic past the point of failure on a single line.

Wave-Forms.—It may be worth notice that Messrs. Beeton, Taylor, and Barr's paper at the Institution of Electrical Engineers on the influence of the shape of the applied potential difference wave on the iron losses of transformers is being reprinted in full in the New York *Electrical World*. In view of some remarks made on the discussion which followed that paper, any editorial or other opinions on the subject from American sources will be awaited with interest.

Finding a Bullet.—A Reuter's telegram from Berlin states that on a visit being paid by Li Hung Chang to the Charlottenburg Polytechnic the Chinese envoy, after being shown a number of experiments with the Röntgen rays, consented to an attempt being made to discover the position of the bullet fired at his head by the assassin at Shimonseki last year. The attempt was successful, and the image of the head which was obtained showed the track of the bullet in the left cheek, and the bullet itself lodged in the tissues slightly below the left eye.

An American Accident.—The *Western Electrician* describes an accident in which a linesman was killed owing to touching a loose wire which had been attached to a high-tension alternating overhead wire by a party of boys. While trying to cut the wire which was causing a leak of current, the linesman received a shock which killed him instantly. It is specially stated that the wire was "attached" in the daytime, so that it is probable that there was no day load, otherwise it would not be very clear how the boys escaped while the linesman was killed.

Rontgen Ray Tube.—In the *Elektrotechnische Zeitschrift* there is figured and described a form of Röntgen ray generating tube, evidently designed to secure as far as possible an effect which shall be as nearly as may be equivalent to a point origin for the radiations. There are two concave cathodes of relatively large size placed opposite to each other, and midway between them is the anode, which is V-shaped, and receives the focussed cathode rays at and near to its angle. A similar arrangement has been described by Mr. Elihu Thomson in America. It will be seen that the whole thing is practically a duplication of the concave cathode and slanting anode used by English workers almost from the beginning.

Aluminium Alloys.—According to Mr. Charles Margot, of Geneva, 72 parts of platinum and 28 of aluminium give an alloy having a golden yellow colour, whilst other tints can be obtained by varying the proportions of the two constituents, but the alloys are liable to be unstable, breaking up spontaneously. The yellow alloy is stable, but is brittle. An aluminium alloy containing 75 to 80 per cent. of cobalt has a colour ranging from straw to brown, is extremely hard, and will scratch glass, but is very brittle. Seventy-two per cent. of palladium with 28 per cent. of aluminium gives an alloy which is remarkable as having a copper-red colour; it is hard and brittle. With 82 parts of nickel to 18 of aluminium a straw colour alloy is produced, which is as hard as tempered steel, and can resist a hammer blow. *Aluminium* says this takes a fine polish, and has a fracture resembling that of bell-metal.

Nowotny Lamp.—In the *Western Electrician* there is a description of an arc lamp brought out by the Nowotny Electric Company of Chicago. It is a hanging lamp, in which the two carbons are not placed end to end, but parallel to each other, and have flat sides. The arc is kept at the end of the carbons by a magnetic field. The carbons are inside a glass globe, which "protects them from the access of fresh air" and prolongs their life. As this lamp is described as of an entirely new type, it may be as well to remark that many years ago, in the early days of electric lighting, a similar arrangement of carbons was tried, but the other way up, the result of the difference of position being that the arc stayed in its place at the top of the

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carbons by itself, and there was no need to provide a magnetising coil to keep it there. Perhaps some day someone will reinvent the Jablochkoff candle and bring that out as an entirely new type of lamp.

Drills Superseded.—The New York *Electrical Review* is responsible for the following tale illustrating the way they do things in the States: A novel way of perforating iron plates is reported from Salt Lake City, says a daily paper. The city is being supplied with electricity for lighting and power, generated 14 miles away in the Big Cottonwood Canon. It was found necessary for the purpose of pipe connections to cut four 48in. openings in the 7ft. penstock, the plates of which were ½in. thick. The workmen began to cut with cape chisels, but the progress made was too exasperatingly slow for the engineer of the works, R. M. Jones, who is known throughout the West as the "cowboy engineer." Mr. Jones took up his rifle, and, using steel bullets cased with copper, shot a line of holes through the plates from a distance of about 30ft. The intervening edges were afterwards easily cut out, and in a very short time the job was finished.

The Telephone Service.—The *Financial Times* has opened its columns to complaints in reference to the telephone service in London. One correspondent imputes "incompetence and crass stupidity—not to say the deliberate defiance"—to the telephone employés. Another says: "When I had it (the telephone) in my office it caused me so much vexation and annoyance that I had to get rid of it to save my nerves from utter destruction. Now I am entirely dependent upon telegrams and messenger boys, and these are not nearly so efficient as the telephone ought to be." A third says: "I think you are very unfair to the National Telephone Company. I have always found the officials models of courtesy and long-suffering. For a long time past I have bothered them every few days with complaints that my telephone is out of order, and I invariably receive a courteous letter in reply, promising that the matter will be seen to. I am bound to say that they are one and all past masters in the art of apologising." But all the letters are anonymous.

The Seguy Ozoniser.—Mr. Gaston Seguy has presented to the Paris Académie des Sciences a note on his new tubular ozonising apparatus. From an illustration reproduced in *L'Electricien* the apparatus appears to be a very compact one. The arrangement is, so to speak, in three storeys, but the dimensions are unfortunately not given. At the bottom is a dynamo, above this three induction coils with make-and-breaks, and on the top stage the three ozonising tubes. Each of these contains seven interior tubes—of course, of smaller diameter—and open at the ends, and the discharge passes from aluminium spirals placed between these inner tubes. The air or oxygen operated on passes through all three of the big tubes in succession. With an E.M.F. of six volts and a primary current of eight amperes, the apparatus produces about 170 milligrammes of ozone per hour. Operating on oxygen as much as 250 milligrammes per hour can be obtained, the proportion being 56 milligrammes per litre of oxygen. With a slower passage of the gas, this proportion rises to 62 milligrammes.

The Physics of the Arc.—The discussion on the "negative resistance" of the arc has taken place at the Physical Society, and matters do not seem much forwarder. To the ordinary man a negative resistance seems very like a contradiction in terms, which can only lead to impossible results. But that is avoided by previously defining what is meant by the "resistance." Of course, any definition which accurately represents the phenomena will do as a basis for mathematical treatment, but the difficulty is that when the same name is used for both it is almost impossible to avoid mixing up the ideas proper enough to a physical conception with those belonging to what is a purely mathematical rendering of observed results. Considering the complicated nature of the phenomena to be dealt with, the argument that from the temperature of the arc being greater than that of the crater, though certainly a presumption against the former containing an energy-giving region, is not absolutely conclusive. Of the facts there should be no manner of doubt; the question is whether the new way of conceiving them is a helpful one. At present the matter seems, as Prof. Rücker said, to be in considerable confusion.

Cable Interruptions.—From the official list of interruptions given in the Berne *Journal Télégraphique* of June 25, it appears that the Ceara-Maraham failure of April 28 was repaired on June 19. The Amazon Company's line beyond Monte Alegre was not reported to be working at the time the list was compiled. Next come two interruptions of Columbian (New Grenada) land lines now repaired and a breakage of communication with Bissao and Bolama, which is not yet repaired. The Cadiz and Teneriffe cable, which failed on June 6, and the Jamaica and Colon (Aspinwall) failure of June 10 are reported as not yet repaired, while a 10-day interruption of the Saigon and Bangkok line was repaired on June 25, apparently just in time for inclusion in the list. There was a two days' interruption of the Gibraltar and Tangiers cable on June 16, and the re-establishment of communications between Gwelo and Beira is of course dependent on circumstances outside the control of any moderate number of telegraphic engineers, even if the latter happen to find magazine rifles included in their outfit. Except two interruptions of Siberian land lines, the rest are either short interruptions repaired within the day or else failures of considerable antiquity.

Electric Fire-Engine.—An electrically-driven fire-engine has been brought out by Mr. Charles Brézol, of Charleville. It consists essentially of a force pump of the usual type driven by a two-pole motor, geared down to give the necessary speed reduction. There are suction and delivery hoses, and the whole is mounted on a two-wheel carriage or barrow with handles, so that one man only is necessary to bring it to the scene of action. *L'Energie Electrique* begins an illustrated description of this apparatus as follows: "Now that the smallest towns in France have a supply and distribution of electricity, and in most cases on a system of overhead wires, what could be more simple than to make use of the electric energy for working fire-engines"; and concludes by drawing the attention of all municipal authorities who have at their disposal a supply of current to this apparatus. Every little town, in this country at least, has not a system of electricity supply by accessible overhead wires, and is not likely to have at present, so that it is to be feared that Mr. Brézol's apparatus will not come into extensive employment. Our contemporary, however, suggests that it might also come in useful for watering public parks. A water supply under pressure would be handier

Electric Lighthouses.—Anything that Mr. Henry MacIver says must command a certain amount of attention in shipping circles, and it is therefore worth notice that he has written to the *Times* a letter showing that he is more than half inclined to believe that—as he cautiously puts it—"there is just a possibility that the disaster (the loss of the 'Drummond Castle') might not have occurred had Ushant been lighted by oil instead of electricity." Mr. MacIver adds: "I am afraid many sailors do not yet appreciate how little penetrating power an electric light

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has in foggy weather." Quite so, but the inference that oil would be better does not immediately follow. Granted that under certain conditions so many candle-power of yellow (oil) light will penetrate a little further than the same number of candles of white (arc) light—neither will go very far in a fog—it is difficult to see how, so long as it contains the proper quantity of yellow light, the fact of the more powerful arc light having also a certain proportion of blue light in addition, which the fog would stop, is to prevent its yellow constituents penetrating. It is not wise to trust to picking up any light in hazy weather, but an argument based on the possibility of that principle not being acted on leads to the absurd result that a bad light is better than a good one.

Iron-Antimony Alloys.—According to a communication made to the Societé française de Physique, Mr. Pierre Weiss has been making experiments on the magnetic properties of alloys of antimony and iron. Mr. Weiss finds that these hold a position between the large class of feebly paramagnetic bodies and the group of iron, nickel, and iron combinations, which have strong magnetic properties. Using a ballistic galvanometer, Mr. Weiss plotted curves for antimony alloys containing from 26 to 56 per cent. of iron. The first of these showed hardly any magnetism, but there is sudden increase in the permeability on passing from samples containing 38 to 42 per cent. This is considered to point to the formation of a compound corresponding to the formula Fe_4Sb_3. Hysteresis diagrams were made with a view of comparison with the Steinmetz formula, which makes the energy dissipated by hysteresis in the course of one cycle equal to some power (not integral) of the maximum magnetisation multiplied by a coefficient which differs for different materials. The value of the exponent as hitherto determined has been 1·6, except in the case of very weak fields. Such iron-antimony alloys as were examined agreed very well with an exponential law, but for an alloy of 53 per cent. of iron the exponent was about 2·17, this figure falling gradually to the standard value of 1·6 as the proportion of iron is increased.

Electric Motorcarts.—Mr. W. Baxter, jun., has contributed an article to the New York *Engineering Magazine* on the subject of the "Horseless Carriage Problem." Mr. Baxter thinks that gas and oil engines having failed completely in competition with electricity for tramcar work will also fail in the same way with motorcarts. "What is true of street cars ought to be equally true of automobiles, as the only difference between them is that the former run on rails and the latter do not." Quite so, but unfortunately it is the trolley car that has prevailed, and clearly the economic performance of the trolley car is not evidence in the case of an accumulator car. Steam, Mr. Baxter considers to have failed completely for quite a quantity of reasons, which, put shortly, amount to the charges of being dangerous, troublesome, disagreeable, dirty, and unable to put on a spurt at starting. With gas and oil engines there are similar difficulties. Therefore nothing remains but the storage battery and electromotor. Again, Mr. Baxter thinks that motorcarts will not be used for pleasure purposes, but for the heavier work of parcels-delivery vans and wagons. Lastly, he looks for improvement in the storage battery. The great point made in favour of the electric motorcart is its ability to make a powerful effort for a short period. Now, this is just the point where, up to the present, animal traction has had the advantage of all kinds of machinery on ordinary roads.

Motorcarts.—The Locomotives on Highways Bill, which appears to be the official title of the measure for the legalisation of motorcarts, has begun its troubles in the Commons. On Tuesday, Mr. Chaplin moved the second reading and to refer the Bill to the Standing Committee on Law. Dr. Tanner opposed the Bill in the interests of sport, considering that "autocars" were "non-sporting machines." Mr. Daly (Monaghan) opposed it also because they breed horses in Ireland. The old fallacy as to broad wheels was brought forward by several members, and there were those who were anxious to tax an industry not yet in existence. Ultimately the Bill got into committee. It is stated that in Paris a committee of the Municipal Council is negotiating with the omnibus company with the object of substituting mechanical for horse power for trams and omnibuses. The Council thinks it desirable that, not only should the tramcars be drawn by mechanical power, but that the omnibuses should also be replaced by horseless vehicles. The Paris Municipal Council may very possibly be right more or less this time, but the opinions and desires of that body are not always accepted as immediately feasible. The first motorcar accident has been chronicled—also from Paris. The Comte de Dion's motor-brake, with nine people in it, got into complications between a farm cart on the wrong side of the way and a steam tramcar, with the result that being turned too sharply it capsized and pitched out its occupants.

Coventry Tramways.—A descriptive article on the subject of the Coventry electric tramways has appeared in the *Birmingham Daily Post.* Our Midland contemporary appears to prefer the system of two sets of poles, one on each side of the street, to one in the middle between the tramlines, but considers span wires much less objectionable than poles and brackets. The article is in no way technical in character, and after a good deal of graphic description of the effect of the wires, guide ropes, etc., seen against the sky, which "at one or two points suggest the rigging of a ship," it is added that "in Coventry the experience of the electric tramway is said to have won over even some of the strongest objectors to the introduction of the system. The cars, in spite of the ugly black jib projecting from the top, are regarded as a welcome change from the steam tram, the traffic is efficiently and expeditiously carried on, and the public are liberally treated." In conclusion, it is stated that "there is less sparking overhead than there is on the Walsall line; but the flashing and crackling underneath the car is sometimes rather alarming. One instance of a horse being startled by this is recorded, but the cars are constantly passing on each side of the cab-stand almost within arm's length, and the horses there take no notice." Evidently the writer of the article did not set out with a bias in favour of electric traction, but the opinions of the Coventry people on the subject seem to have impressed him.

Lamp Exhausting.—There was described some time ago in the *Zeitschrift für Beleuchtung* a method of exhausting incandescent lamps in which a chemical process is used in conjunction with the air pump. It is stated that most of the lamp factories in Germany are now using such chemical processes. In the tube attached to the lamp for exhausting it a piece of amorphous red phosphorus is introduced, the amount of which must be found empirically for each type of lamp. While it is being exhausted with the pump, this tube is heated carefully with a Bunsen burner; and when the vacuum is sufficient, the normal current is passed through the lamp and then increased gradually up to about three times the normal voltage, when a violet light will appear at the end of the filament. A few moments later a blue light will appear around the filament. The current should be reversed frequently, and after having run for 10 to 20 seconds at the high voltage the blue light will expand throughout the whole globe, and

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at that moment the lamp must be sealed off so as to include the phosphorus. The lamp is then run again and heated at the tube which contains the phosphorus. A reaction will suddenly take place and the blue light will disappear, a scarcely visible light-brown deposit being formed on the glass, which it is said does not affect the candle-power. When a lamp exhausted in this way is tested with a Ruhmkorff coil, neither phosphorescence nor a current will be found to exist. The whole operation requires only 1·5 to 2 minutes with an experienced workman.

Accumulators for Telegraphic Work.—On the subject of the use of storage batteries in telegraphic offices the New York *Electrical World* remarks that in such work "storage batteries find an ideal field of application, and that their advantages are fully recognised by the telegraph officials is evident from the fact that their use in telegraph work is increasing rapidly." According to Mr. Maurice Barnett in an article on the subject, 3,116 storage cells of different capacities are now doing work which formerly required 20,407 primary (gravity) cells to perform. The original cost of the batteries is given as £2,000, and that of the storage cells about £1,700. After adding to the latter figures the cost of the auxiliary apparatus necessary for the operation of the storage battery plant, the difference is still in favour of the storage battery. The advantages and economies are still further increased by the large saving in space. "Output for output the primary battery requires four to six times more space than a storage battery, and space in most busy centres nowadays is easily resolved into its equivalent in dollars and cents. Another economy in favour of the storage battery plant is in the cost of maintenance. The primary battery, such as is used in telegraph work, is proverbially wasteful, yet its use has been tolerated because nothing better had been put forward to take its place until the advent of the motor dynamo and the improved storage cell. The latter, as manufactured to-day, is a device far more reliable in service than formerly, and it is quite as much due to the certainty that a given cell will supply a definite output as to the more weighty economies above referred to that the storage battery is finding so much favour in this particular branch of electrical industry."

Institution of Electrical Engineers.—The conversazione of the Institution of Electrical Engineers was given on Thursday, June 25, at the Royal Institution of Painters in Water-Colours, Piccadilly. There was a very large attendance indeed, the spacious rooms of the Painters in Water-Colours being at one portion of the evening quite crowded. Dr. Hopkinson and Mrs. Hopkinson received the numerous guests on their entrance. Among a large number of eminent persons present the following names may be mentioned: Sir Frederick Abel, Bart., K.C.B., F.R.S., Prof. W. Grylls Adams, F.R.S., Prof. Armstrong, F.R.S., Prof. W. E. Ayrton, F.R.S., Mr. Frank Bailey, Sir Benjamin Baker, K.C.M.G., Mr. A. E. Baylor (U.S.A.), Captain W. P. Brett, R.E., Mr. H. W. Christmas (Consul-General for Servia), Prof. Cleve, Captain E. W. Creak, R.N., F.R.S., Mr. R. E. Crompton, Prof. W. Crookes, F.R.S., Mr. W. B. Esson, Mr. S. Z. de Ferranti, Prof. G. Carey Foster, F.R.S., Mr. Charles Hawksley, Prof. D. E. Hughes, F.R.S., Mr. E. H. Johnson (U.S.A.), Lord Kelvin, D.C.L., F.R.S., Prof. A. B. W. Kennedy, F.R.S., Sir Henry Mance, C.I.E., Mr. Commerford Martin (U.S.A.), Mr. Kenric Murray, Major Cooper Penrose, R.E., Prof. John Perry, F.R.S., Mr. W. H. Preece, C.B., F.R.S., Prof. W. C. Roberts Austen, C.B., F.R.S., Major Ruck, R.E., Mr. Alexander Siemens, Mr. C. E. Spagnoletti, Mr. Augustus Stroh, Mr. J. W. Swan, F.R.S., Mr. J. Swinburne, Prof. S. P. Thompson, F.R.S., Sir E. Leader Williams, Mr. Edward Woods (past-president Institution of Civil Engineers), Major-General C. E. Webber, C.B. The Æolian Ladies' Orchestra played a selection of music, under the conductorship of Mr. R. Watson, and later on, when the crowd had thinned sufficiently to permit of it, a waltz or two wound up the evening.

Resistance of Alloys.—In reference to the suggestion of Lord Rayleigh's that part of the abnormal resistance of alloys might be due to a thermo-electric effect, it appears that some time ago Messrs. W. C. McMillan and R. H. Housman, of Mason College, Birmingham, endeavoured to determine the point experimentally. It is evident that if a reversal of current could be made so rapidly that the differences of temperature which are assumed by the hypothesis to be set up within the alloy would not have time to distribute themselves, the thermo-electric back E.M.F. could be eliminated. The method ultimately adopted was to balance the resistance of two pieces of wire, copper and alloy, and by means of a secohm-meter try if there appeared to be any diminution of the resistance of the alloy when the current was rapidly reversed. It is stated that indications which would support the correctness of the hypothesis were in this way obtained. It seems obviously impossible to get anything approaching quantitative results, since, the parts involved being so small, the redistribution of temperature must be exceedingly rapid. Moreover, apart from other disturbing effects, which would be difficult to eliminate, it does not appear easy to be certain that the alloy is absolutely homogeneous in character over measurable distances. It should be added that Messrs. McMillan and Housman's idea is that the effect is not a molecular one, but that one of the constituents of the alloy exists in the form of very minute "crystals" embedded either in the other or in a true mixture. If that were so, alloys which are chemical compounds would not give the effect; but that deduction is useless for practical purposes, since it is impossible to get such a chemical compound which does not contain some of either one or both of its constituents in an uncombined form as an "impurity."

Paraffin Lamps.—Sir Henry Roscoe and Prof. Dewar have been giving evidence before the House of Commons Committee on petroleum. Sir Henry Roscoe said there was no such thing known at present as a lamp which could be designated a safety lamp, and even if there were such a thing he did not see how its use could be insisted on by the Legislature. Therefore he had come to the conclusion that a change in the properties of the oils used must rather be looked to for an amelioration of the present state of things. The oils now in common use in this country, even with the ordinary precautions, were dangerous. After describing various experiments, Sir Henry Roscoe added that the general conclusions he had arrived at were, first of all, that the flash point was too low, and, second, that it was not possible to fix a practical flash point so high that all danger from fire could be avoided; but that if the flash point were raised to 100 or 105, a considerable diminution in the number of accidents from explosion and fire might be looked for. On the other hand, Prof. Dewar said from experiments he had made he had come to the conclusion that, if Parliament undertook legislation that would convey to the public that oil could be safely used in the present lamps, they would have to fix the flash point at 212deg. F., so that really it was impracticable to insure safety in the use of mineral oils by careless persons in the present lamps by simply raising the flash point. There was but little difference in the risk of accident from the use of oil of 100 flashing point and from

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the use of oil of 73 flashing point in the lamps at present in use. From the reports of the chief officer of the fire brigade it appeared that in 1890 there were 271 lamp accidents and 473 in 1895.

Electricity in Agriculture.—The Chicago *Electrical Journal* contains a short account, apparently taken from another paper, of how a certain Mr. Israel Hogeland, of that city, has patented a device "which will allow a farmer to plough his field, harrow it, put in the seed, and, when the crop has grown, to harvest it by electricity." There is a feed-wire on all four sides of the field (this seems lavish; one should be enough), and "the farm machinery is provided with a trolley, which consists of a wire so arranged that it will wind or unwind on a cylinder on the back of the machine." The description is somewhat compressed—perhaps it is from this cause that that rather essential part the motor has got left out, but, for all we know to the contrary, the arrangement may be more practical than the description reads. However, quite apart from Mr. Hogeland's patent, there are those well able to judge who maintain that ultimately the immense "bonanza" farms worked by companies will supersede in many agricultural districts what the Americans consider "small" occupations of 300 acres or so. When that comes about it means steam cultivation, and it is obvious that an insulated wire carrying a current ought to be a more economical means of conveying energy to a plough or other agricultural machine than the wire rope now used in steam ploughing tackle. Recently some experiments have been made in this direction in Germany, and it is now stated that the German Government have taken the matter up, and are making trials with electrically-driven ploughs on the Sillium Estate in the Upper Hartz, but no figures as to the results are available, while the figures that are given as the results of similar experiments made by the Union Elektricitäts-Gesellschaft, which work out at nearly 15 h.p. to a ploughshare, are vitiated for purposes of comparison by the furrows being much broader and deeper than any that are ever drawn in this country.

The Society of Arts.—The Albert medal of the Society of Arts has been awarded, with the approval of the Prince of Wales, the president of the society, to Prof. David Edward Hughes, F.R.S., "in recognition of the services he has rendered to arts, manufactures, and commerce by his numerous inventions in electricity and magnetism, especially the printing telegraph and the microphone." Prof. Hughes is to be congratulated upon the receipt of a merited distinction. The council of the society have awarded silver medals to the following readers of papers during the session 1895-96: W. J. Dibdin, for his paper on "Standards of Light"; A. J. Hipkins, for his paper on "The Standard for Musical Pitch"; A. A. Campbell Swinton, for his paper on "Röntgen's Photography of the Invisible"; Dr. D. Morris, for his paper on "Bahamas Sisal Industry"; Edward W. Badger, for his paper on "Fruit and Vegetable Drying"; E. W. Moir, M.I.C.E., for his paper on "Tunnelling by Compressed Air"; Colonel R. G. Woodthorpe, C.B., R.E., for his paper on "The Shan Hills, their Peoples and Products"; J. H. Glass, for his paper on "The Great Landslip at Gohna, in Gurhwal, and the Measures adopted to Prevent Serious Loss of Life"; G. W. Christison, for his paper on "Tea-Planting in Darjeeling"; Frank Cundall, for his paper on "Jamaica in the Past and Present"; G. Scott Elliot, for his paper on "The Commercial Prospects of English East Africa and British Central Africa"; Charles R. Valentine, for his paper on "The Colonies and the Supply of Dairy Produce and the Products of Petite Culture"; Gleeson White, for his paper on "The Poster and its Artistic Possibilities"; William Burton, for his paper on "The Palette of the Potter"; and George Simonds, for his paper on "Bronze Casting in Europe." At the annual general meeting the following were the new vice-presidents elected to replace those retiring by seniority: Captain Abney, Sir G. Birdwood, Sir F. Bramwell, Viscount Cross, Mr. G. N. Curzon. The new members of council were Messrs. J. G. Gordon, H. G. Harris, J. S. Neville, and J. M. Thomson.

Edison's New Lamp.—As a general rule we do not care to reproduce interviews of Mr. Edison by representatives of non-technical papers, since it is usually hopeless to separate Mr. Edison's ideas from those of the reporter. The following, however, taken from an interview with a representative of the New York journal *Electricity* should be reliable, and shows pretty clearly the present position of things. It is plain that at present a tube has not been obtained which can be run continuously for any time. That is the important point. The description of platinum as the "base" in potassium platino-cyanide is a minor matter, but the use of the expression "ultra-violet sound-waves" shows how Mr. Edison's sound theory originated, and incidentally demonstrates the danger of semi-poetical descriptions of this character. Our New York contemporary says: "The tube was lit up a large number of times for our representative, but the current was kept on only for a few minutes at a time to prevent the deterioration of the vacuum. The lamp, Mr. Edison said, was giving about 2 c.p. He had run it up higher, but was afraid to do so as it was the only good tube he now had. He was having some larger ones made which he expected would give about 10 c.p. It was difficult to believe that the bulb shown was giving so little light, so deceptive are such things to the eye, but Mr. Edison insisted that it was giving no more. Asked as to the energy consumed, he said he had placed a Weston ammeter and voltmeter in the primary of the induction coil, and the readings were two amperes at $\frac{3}{10}$ of a volt. This would indicate only $\frac{3}{10}$ of a watt per candle-power, which is an extraordinary efficiency when we consider that three watts are a good efficiency for the incandescent lamp and half-watt for the arc lamp. He did not know what effect the self-induction of the coil had upon the readings of the instruments, and asked what effect it had in testing Moore's tubes. When the writer told him that his tests of the motor circuits described in our last issue gave very concordant but lower results than tests made in the interrupted circuit, he exclaimed with enthusiasm, 'Well, then, I am on the safe side.' Our representative told him that he did not think the error occasioned by self-induction was large, and upon being asked 'How large?' replied 'Probably not over 10 or 15 per cent.' Speaking of economy, our representative, turning to the huge induction coil, asked, 'How about that?' 'Oh,' said Edison, 'that's rotten; you've sounded the keynote exactly. This part (putting his hand on the tube) is all right—it is fine; but that part (pointing to the induction coil) is rotten.' Asked if he still maintained the theory that the X rays were sound-waves, he said that he did. That theory had sufficed for all of his experimental data, and so long as it continued to do so he intended to stick to it. He explained further that in a fluorescent salt the heavier element acted as a sort of fulcrum around which the lighter element vibrated. Thus, in the platino cyanides the cyanogen was the lighter element and the base the heavier. When this salt was struck by these ultra-violet sound-waves, the molecules as a whole could not be set in vibration, but the lighter radicle—the cyanogen—could, and in this way the substance emitted light."

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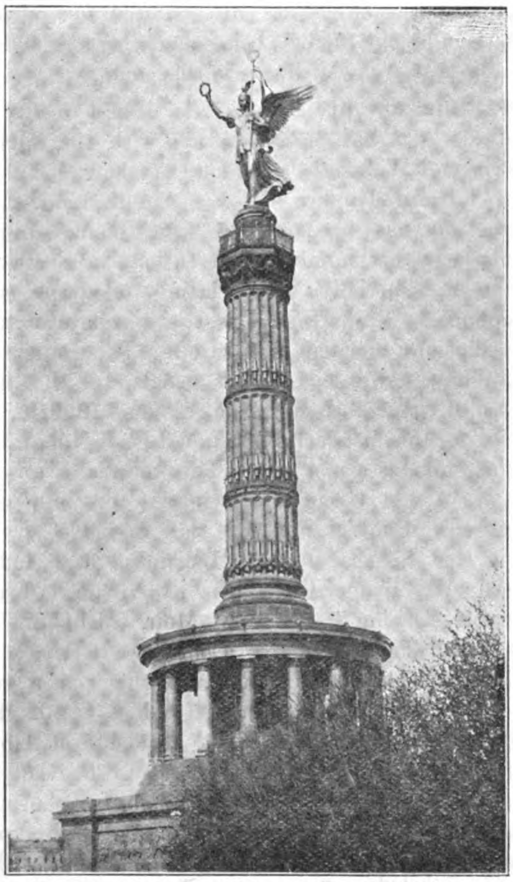
THE 1896 MEETING OF THE VERBAND DEUTSCHER ELEKTROTECHNIKER IN BERLIN.

(BY OUR SPECIAL CORRESPONDENT.)

It was with great pleasure that I received instructions to proceed to Berlin and to report for the *Electrical Engineer* the doings of the above society at their annual meeting. The anticipation of again enjoying the hospitality of the German engineers and once more meeting the friends made in Munich last year made me start early, in order to miss nothing of the proceedings. On my way through Cologne I was welcomed by Mr. C. P. Feldmann, of the Helios Company, and spent with him some happy and instructive hours. The gist of our conversation on the different systems of electric mains and their calculation will be found elsewhere. From Cologne to Berlin I endured 11 hours of a melting process, which considerably lowered my insulation resistance, although, at the same time, there was a slight increase in capacity. I travelled by the train which runs on to St. Petersburg, and although the arrangements were most comfortable, the dust accumulated in the carriages to such an alarming extent that it became a question whether the passengers would be visible when they reached Russia. The first evening spent in Berlin I was kindly invited by Mr. Gisbert Kapp, the able secretary of the Verband, to a private dinner, where I met the president, Prof. Slaby, and three active members of the committee—Dr. Budde (of Siemens and Halske), Mr. Naglo, and Mr. Jordan. After leaving the table I had a few minutes' most interesting conversation with Prof. Slaby concerning the state of the electric lighting industry in England. He was surprised to hear that the municipalities were taking up the supply of electric light with success, and assured me that in Germany it was rather an exception to find municipal enterprise up to date. So many undertakings owned by German town authorities are allowed to stand still without taking advantage of new improvements. Hence Prof. Slaby stated distinctly that such matters were better left in the hands of companies, whose interests lie in giving a cheap and efficient supply. I also gathered from him that the independent consulting engineer is more scarce in Germany, as there the most eminent consulting men also act as contractors at times, and hence are apt to establish business relations with certain firms. A town would thus have difficulty in finding engineers to advise them without at the same time putting themselves into a restricted market.

The general programme of the meeting was commenced on Wednesday, the 17th ult., by a social gathering in the Reichshalle, Leipzigerstrasse, when a thoroughly German entertainment was provided, in which the drinking of light German beer formed no inconsiderable part. The theatre consists of a large ground floor on one level, and one gallery only, with boxes in front. The ground floor was arranged with tables running full length, at which the gentlemen sat, while the ladies, dressed in gay attire, adorned the boxes. The programme commenced by a long welcoming speech from one of the authorities, which was followed by singing. A "Salamander" was then performed, which is certainly a feature unknown in England.

The Houses of Parliament, Berlin.



The "Siegessaale," Berlin, erected to commemorate the victories in the Wars of 1839, 1866, and 1871.

The first requirement of this performance is that every beer-jug shall be emptied. The jugs are then rattled together to a well-known tune, and finally crashed on to the

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tables with a noise like a thunder clap. A series of short theatrical performances, in which the acting was admirably carried out by members of the electrical profession, were given at frequent intervals, interspersed by glee singing. Towards the end of the evening a dozen gentlemen, dressed as Spanish students, with the typical wooden spoon in their caps, came on the stage and sang "The Student of Cadiz." After the song was done, they scaled the boxes by means of ladders decorated with evergreens and distributed a fan and bunch of roses to each lady. Another interesting skit was that designed to imitate a recently-invented type-

Potential Difference.

Capacity.

setting machine on view in the Berlin Exhibition. A man seated at the machine was supposed to control it by his thoughts, and the sparks given out by the type-setter showed the rate at which the work was proceeding. At one period of the run the machine gained in speed and emitted a howling noise due, as the demonstrator explained, to the fact that the operator had made use of a pun. The machine was next supposed to print off the *Bier Zeitunq*, which was immediately distributed amongst the guests. This beer journal is a most artistic production and the literary work in it is also exceedingly amusing, although the point of several of the advertisements cannot be understood without local knowledge. The following

Insulator.

Pressure.

Short Circuit.

will give a general idea of the style of advertisements at the end of the paper:

WANTED, immediately, an ELECTRICAL COOK, with college diploma, well up in Maxwell's Theories and used to repairs, for looking after an electrical stove.

OBJECTIONS to the INTRODUCTION of ELECTRICAL TRAMS KEPT IN STOCK in great variety.—Apply, THE MUNICIPAL AUTHORITIES OF BERLIN.

WANTED, TO BUY an ELECTRICAL INCUBATOR, to HATCH NEW PROPOSALS for LEVYING TAXES.—Apply to the CHANCELLOR OF THE EXCHEQUER.

ELECTRICAL WORKS OF FERD, SENGERICH, AND CO., Berlin, Department I.—Electric Railways, System Wertheim.—ONE MILE GIVEN AWAY with each 12 miles ordered. Price-reducing valves. Attractive surprises for chief engineers.

The body of the journal shows no great respect to the electrical profession generally. Thus the first article is a

Magnetic Attraction.

description of the Berlin Exhibition, with illustrations, and the view of the grounds on the second evening shows that total darkness reigned supreme. The illustrated electrical scenes are most carefully prepared, but suggest that the editor of the *Bier Zeitung* was no amateur in the art of imbibing. The Pelton wheel used as the prime mover in the polyphase transmission scheme bears out this latter view. The pleasant evening was only marred by the heat, which was almost unbearable.

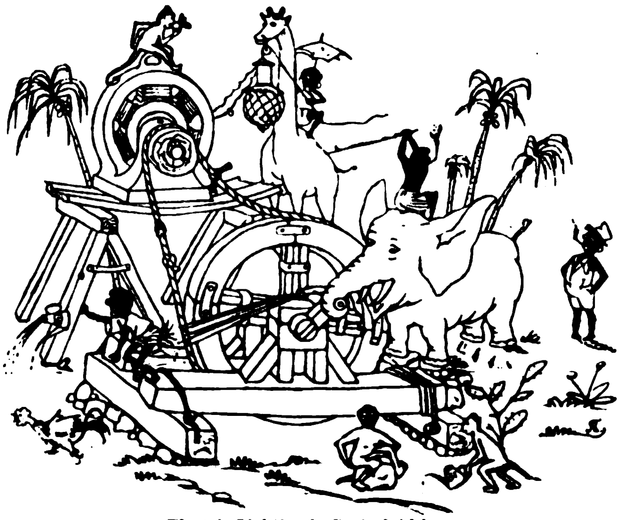
A Polyphase System.

The public business of the meeting began on Thursday, June 18, in the Architektenhaus, Wilhelmstrasse. At it there was a large gathering of men who have taken an active part in the development of the electrical industry in Germany. I was pleased to find there a number of engineers from Vienna whom I met at Munich last year.

Interview with Mr. C. P. Feldmann, of Cologne, on Electric Light Mains.

On my way through Cologne *en route* for Berlin I spent a few pleasant hours in the company of Mr. C. P. Feldmann, the chief electrician of the Helios Company. He kindly showed me over the Cologne electricity works, which contains the flywheel alternators manufactured by the above firm. These works may justly claim to have originated the use of flywheel dynamos direct coupled to slow-speed horizontal engines. It was in these works that Mr. A. Colson, of Leicester, obtained his conviction that this system was the correct one for Leicester, and his example was followed afterwards by other engineers.

Mr. Feldmann has devoted great attention to the calculation of electric mains and networks, and the following *résumé* of our conversation on the subject will be of interest. Mr. Feldmann considers that the first man to publish a technical article upon the calculations of electric mains, after Lord Kelvin and Prof. Forbes, was Mr. C. Hochenegg, who in 1887 made public a graphical method of investigating the drop of simple examples of ring distribution. In 1891, Mr. J. Herzog, of



Electric Lighting in Central Africa.

Budapest, in conjunction with Mr. L. Stark, took the matter up and investigated completely a physical and not merely mathematical method of calculation for electric systems of distribution. The method employed

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starts from the fact that in each closed ring or mesh there must be one consumer who gets current from either side. This was known, of course, before 1891, and there were several methods of trial and error in use to find this place where the mesh may be thought cut without altering for a given consumption the supply currents in either part. Several engineers were looking for some simple way of finding the supply currents without the laborious trial and error method, but Messrs. Herzog and Stark showed clearly that the section may be taken anywhere in the mesh; the simple equation shows that the drop in E.M.F. either way round the mesh from the given feeding point to the assumed section is equal, giving not only the real section but also the real distribution of supply for the given consumer. Later on Messrs. Herzog and Feldmann enlarged the method, and developed a complete system of calculation on paper on undue loads on any given branch of any network. In their book, called "Berechnung elektrischer Leitungsnetre in Theorie und Praxis"—*i.e.*, "Calculation of Electric Networks in Theory and Practice"—their system is fully described, and the system is also referred to in our columns.*

Mr. Feldmann agreed with me that the treatment without practical experience would be cumbersome, but when combined with a previous knowledge of the subject, an extremely well-balanced network could be easily designed. His procedure in laying-out a new town is roughly as follows: The main streets are selected, and together with those side streets likely to provide consumers, are marked on a convenient scale. The probable consumption in these streets can be approximately determined from the previous

MR. C. P. FELDMANN.

consumption of gas, or from a general knowledge of the character of the town, the country, and the customs of the people. Mr. Feldmann then proceeds to lay down complete rings of mains in these streets to supply the presupposed load, and then tests the distribution of current in the various branches by the above methods. The section of the mains is thus chosen according to experience, and changed if the distribution found requires it. It must be remembered that the engineer only cares for the current in the sections and the drop of voltage, and does not care at all for the resistance of the individual sections. Mr. Feldmann was directly opposed to the practice of using a low-pressure network with alternate-current distribution. He admitted that the no-load losses in the transformers would be higher if individual transformers were placed in the consumers' houses, and that the ratio of units sold to units generated could also be increased by the use of low-pressure distribution. He objected to this latter system on the ground of first cost, and because the good regulation of a high-pressure distribution was nullified in the low-pressure mains. In his opinion, when good transformers are used, the increased cost of magnetising the larger number of small transformers would be more than counterbalanced by the additional charges for interest on capital and depreciation on the low-pressure system, the increase of capital being caused by the secondary network and the transformer sub-stations. He thought that none of the systems worked out so far for switching of transformers would really work in daily practice, and that especially in Germany the risk of interference with telephone circuits was also largely increased by using a secondary network. With single transformers any consumer may have earth on his circuit without disturbing his neighbour or the telephones. With a secondary network the whole of the customers and telephones may be annoyed by two or three earths, which cannot be avoided in a low-pressure network.

I afterwards proceeded to question Mr. Feldmann about the series system of lighting introduced by the Helios Company. He told me that their managing director, Mr. Carl Coerper, devised the scheme for the lighting of Kiel Canal in 1893. The main feature of this system is that of placing a choking coil in parallel with each lamp. If, then, from any causes the lamp goes out the choking coil immediately takes up the whole current of the circuit, and at the same time keeps the voltage constant.* The lighting of the Kiel Canal with incandescent lamps showed the utility of the system. Although the canal is over 60 miles long, only two generating stations are used, and there are only four series circuits of lamps. Each circuit consists of some 250 25-volt lamps in series, the total voltage of the whole circuit being 7,500. The current taken by the lamps is three amperes, while the choking coils take from six to seven, but the current through the choking coil being almost at right angles (in phase) to that through the lamp, the whole current of the circuit is only about 7·5 amperes. The elasticity of this system is such that 30 per cent. of the lamps can be extinguished without requiring any regulation of the generators to prevent an excess current in the other lamps. The extra load taken by the circuits to keep the choking coils excited is about 10 per cent., which loss can be well afforded on account of the great saving in capital charges due to the simplicity of this system. Although the lighting at the Kiel Canal is done by incandescent lamps, Mr. Feldmann assured me that Mr. Coerper's arrangement was equally good for arc lighting. When six arc lamps are connected in series with choking coils across their terminals, two of the lamps can be switched out without affecting the others or requiring any alteration in the voltage of the supply. The Helios Company are applying this system for street-lighting with arc lamps in series of 200-volt transformers, and find that the choking coils assist the regulation of the lamps considerably; they have even burnt 20 lamps in series, of which six to seven might be extinguished.

(To be continued.)

RAILWAY BLOCK SIGNALLING.

BY J. PIGG.

The "block" telegraph system in use for regulating traffic is probably the most extensive of all the adaptations of electricity to railway work, and its "use-value" is undoubtedly greater than that of any other form of electrical apparatus in use upon railways. The development of the "block" system has been the work of the last 30 years approximately; previous to that time traffic was worked in quite a different fashion to that in use at present.

The fundamental principle of the "block" was at first derided, and the name chosen was considered as characteristic of the condition traffic was likely to get into under any such system of working. That there should be any reason to prevent a driver from proceeding as far as his visionary powers assured him the line was clear, or that any train should be prevented from "bumping" a preceding train—gently, of course—was considered absurd, and there were not wanting those who predicted the early demise of this or any other system which involved restrictions being put

* "The Cologne Electricity Works," *Electrical Engineer*, vol. xvii., pages 89, 120, and 231.

* According to theory, it should require a higher voltage to keep constant currents, but then, luckily, the self-induction coefficient is not constant, but varies in well-designed apparatus.

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on the free passage of traffic. This, of course, was before the era of express trains travelling at rates varying between 60 and 70 miles per hour. In those days it was no uncommon thing for agile persons to boast of their ability to leave trains at any point that was most suitable. At that date railways were comparatively small concerns compared with what they have, by extensions and amalgamations, now become, and the volume of traffic handled by one railway was correspondingly small.

The prophecies referred to have, however, been falsified, and railway traffic is now carried with a regularity and freedom from accident which is remarkable when the quantity of material handled and the area covered is taken into consideration. To this precision, and the safety resulting therefrom, the "block" has undoubtedly contributed quite as much as any other branch of engineering.

The first example of an electrical signalling instrument in use with which the writer became acquainted is that shown by Figs. 1 and 2. These instruments were patented by Alex. Bain, and were in use between the ends of a tunnel on the old Stockton and Darlington Railway, and were replaced by C. V. Walker's block instruments about 1868. The instruments were provided with bells, not shown, the hammers of which were held up by trip-gear, which was released by the deflection of the needle, the hammer being raised again, by hand, after every stroke.

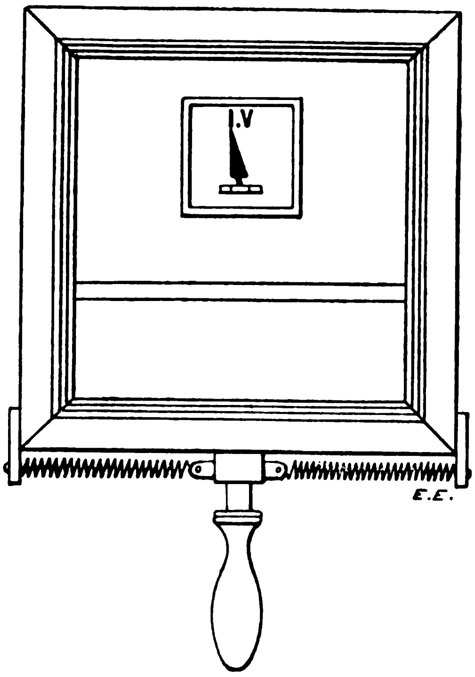

FIG. 1.—Alexander Bain's Signalling Instrument.

CODE OF SIGNALS AND ALPHABET.

Yes	A	I	IVI	O	Is an engine near
Engine out	B	II	IVII	P	Send train on main-way
Two engines	C	III	IIVI	Q	Stop traffic on main-way
Three engines	D	IIII	VVI	R	Repeat the last letter
I understand	E	V	IVV	S	Do you understand
Engine entered	F	VV	VIV	T	Wagons left in
Stop traffic on by-way	G	VVV	VVVI	U	Is all out
	H	VVVV	IVVV	V	No tail signal
No	I	IV	VIVV	W	Hagger leases
I am going to speak in			VVIV	X	Train on main-way
letters	J	IIV	VVII	Y	All is right
Engine returned back	K	IIIV	VIVI	Z	I am showing the telegraph to a friend
Is all right	L	VI			
Train on by-way	M	VII	IVIV		Stop traffic on by-way
Sent train on by-way	N	VIII			

RULES TO BE OBSERVED.—1st. The bell is to be rung at the commencement of every conversation.—2nd. The V in the course of conversation always to form part of it and to be considered as the bell.—3rd. At the close of every conversation the bell handles must be set for ringing.—4th. The plates of the battery must be put into the trough at the beginning of the conversation and taken out when finished.

The code of signals in use for ordinary work and the alphabet for conversation on matters not provided for in the code are given, together with the rules. The signal, "I am showing the telegraph to a friend," and the rule, "The plates of the battery must be put into the trough at the beginning of the conversation and taken out when finished," are very quaint, and would be difficult to duplicate at present. The signal, "Engine returned back," is also significant of the free and easy manner in which things were carried on in the earlier days of railways.

"Block" working may, for convenience, be divided into two main parts, "absolute" and "permissive." "Absolute" block may again be divided into "double-line" and "single-line" working, as the requirements for these are somewhat different.

Absolute block working consists essentially in preserving a certain space between successive trains on the same line of rails, this space varying in different localities from a few miles to, perhaps, 300 or 400 yards, or less, according to the amount of traffic, the number of junctions, and the distance between them.

Permissive block working imposes a space limit, not between individual trains, but between groups of trains only. With absolute block working two trains in one section on the same pair of lines are not permissible; with the permissive block any number of trains up to a prearranged limit may be admitted into a section.

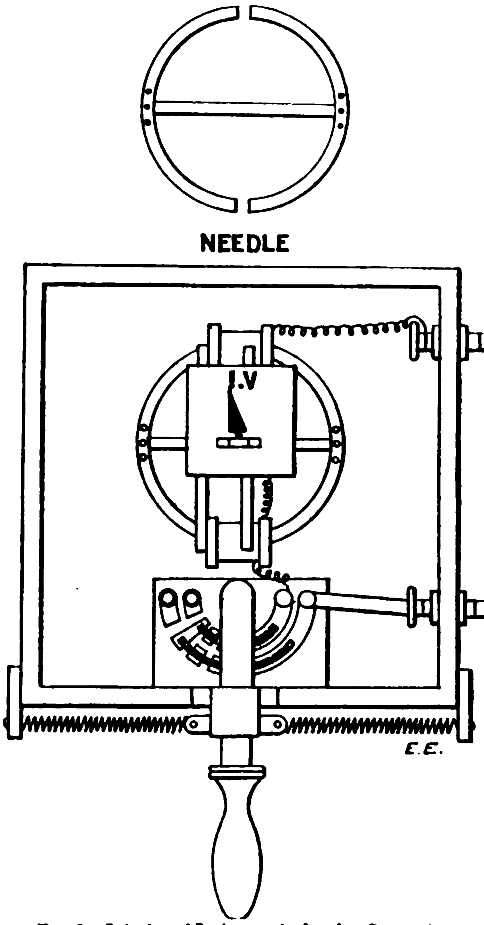

FIG. 2.—Interior of Instrument, showing Commutator.

In order to carry out either system of block working, cabins are built at suitable points on the line side, and in these cabins the apparatus for working the outside mechanical signals which control the passage of trains into or out of the sections, and the "block" apparatus for indicating the condition of the lines and for sending the various signals required between the two ends of a section, are placed. As pointed out in a previous article, the receiving end of a section of line is of much greater importance than the sending end, but a cabin which is the sending end for "up-line" trains will be the receiving end for "down-line" trains, and thus the average responsibility is equal, and the disparity only exists in considering individual trains.

At one time considerable discussion centred on the most suitable form of instrument for indicating the condition of the line. Some inventors pinned their faith to instruments in which the indicator was a small semaphore arm, or a fac-simile in miniature of the outdoor mechanical signal, and argued that the train distinguishing signalling apparatus should be of a different character to the indicating apparatus, but not necessarily a separate instrument, since they served distinct purposes, and that uniformity in design of the mechanical signals and the block indicator was desirable in many respects. Others, again, preferred some form of the "needle" instrument, so familiar on railways, and con-

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tended that the indication was in any case arbitrary, and consequently when once established and understood the character of the indication was immaterial. It was further contended by the advocates of the single-needle instrument that it allowed a greater variety of signals to be sent, and that it also possessed the further advantage of cheapness.

Intimately connected with the most suitable character of block indicator is another point which seems to have been considered of some importance by inventors of block apparatus, and upon which much ingenuity has been exercised. This is the reduction of the number of line wires to one, and the ability to perform all the operations required for double-line block working by one line wire is still often urged as a recommendation on the score of smaller cost for erection of wires and their maintenance.

Before discussing the suitability of any particular form of instrument, it is necessary, in order to arrive at a proper understanding of the requirements, to know something of the traffic arrangements. Most people are acquainted with the broad principles of block working, but few outside the railway service have more than a superficial acquaintance with the actual working of the system on a large railway. The comments of the average layman on the breakdown of arrangements which may have led to an accident have generally to be heavily discounted on account of his evident lack of knowledge of the subject, and are to be regarded as evidence of courage more than of experience.

Railway traffic is divided into classes, the relative importance of which are defined in the regulations of the various companies. Thus, express passenger trains take precedence of all other classes, and any train of another class which is likely to delay an express passenger train must be shunted to allow the latter to pass. Again, ordinary, or slow passenger trains, take precedence of all trains except express passenger trains. Trains conveying perishable goods (fish, yeast, butter, fresh meat, etc.), or goods for a special market, take precedence of all trains except passenger trains. Express goods trains conveying through traffic only come next, and after these "through mineral," "pickup goods," "slow mineral," "ballast trains," etc.

The more important trains carry some distinguishing board during the day and a particular arrangement of headlights at night to indicate their character to those regulating the traffic. Each class of train has its own distinctive signals on the block apparatus, and, in addition, the more important trains have their time of departure from certain stations telegraphed forward to different points on their route, so that arrangements may be made to ensure a clear course for them without unnecessary delay to other traffic, which might, in the event of an important train being behind its scheduled time, be kept waiting unnecessarily.

It will be readily seen from the foregoing that a considerable variety of signals will be necessary for the working of traffic; and in addition to these there are others which are designed to meet such emergencies as experience shows as likely to arise, and for special purposes other than traffic working proper. Signals may, therefore, be divided into three classes: (*a*) those for ordinary working; (*b*) those for emergencies; (*c*) those for special purposes.

The ordinary signals may be further divided into three classes: those which are preliminary to the entrance of a train into the section, and which partake of the nature of a request for permission to send a train forward; those which notify the actual entrance of a train into the section; and those which notify that a train previously signalled has passed out of the section.

The emergency signals are of a different character, and consist for the most part of bell signals, codes of rings being established to convey information on special points of importance. Of this class are such signals as the "Obstruction danger signal," "Stop and examine train," "Vehicles running away on right line," "Vehicles running back on wrong line," "Train passed without tail lamp," etc. The third division consists of such signals as indicate testing of the block apparatus, or controlled mechanical signals, "time signal" and others which, whilst of some importance in their way, are not directly connected with the working of traffic.

Passing from the general to the particular, it may be said that on one large railway worked on the three-wire "needle" block system the number of bell signals was 19 and the number of dial signals was 16 prior to April, 1895. Of the former, four were of the nature of an enquiry, or the preliminary "Be ready" signal for as many different classes of trains, six were emergency signals, one "Train entering section" signal, and eight special signals. Of the dial signals, 12 were for distinguishing the various classes of trains when sent on line, one was "Line clear" signal; two were for shunting purposes, and one was to indicate the necessity for forwarding the next train at "Caution."

A revised code of signals has recently been brought into operation, and a comparative study of the old and new codes reveals an increase in the number of signals of all kinds from 35 to 45. The number of bell signals has increased from 19 to 31, whilst the dial signals have decreased from 16 to 14.

Of the bell signals under the revised code, one is for "Attention," 11 are of the nature of an enquiry or "Is line clear for, etc.," this form being substituted for the "Be ready" of the previous code, one "Train entering section," seven emergency signals, and 11 special signals. Of the 14 dial signals, six are descriptive of trains and five are special signals. On another large railway, also worked on the three-wire block, the whole of the signals, numbering 34, are given upon the bell, and the dial instruments are used as indicators of the condition of the line only.

It will be readily seen from the foregoing, without further analysis of the codes of signals, that the transmission of signals indicating the character of approaching trains is an important function of block apparatus, and, further, that the tendency at present seems to be to increase the number of signals to be transmitted. Block instruments, therefore, to give general satisfaction on lines carrying a great variety of traffic, must be such as to allow of a corresponding variety of signals, without unnecessarily cumbrous or intricate codes, in order that the various classes of trains may be distinguished from each other.

(To be continued.)

THE PRINCIPLES OF ALTERNATE-CURRENT WORKING.*

BY ALFRED HAY, B.Sc.(EDIN.), A.I.E.E.

(Continued from page 692.)

9. All physical quantities may be divided into two classes—viz., *scalar* and *vector* quantities. A *scalar* quantity has *magnitude*, but no direction. A *vector* quantity possesses both *magnitude and direction.* Thus, a sum of money, the temperature of the water or steam inside a boiler, the power of an engine, are all examples of *scalar* quantities. The characteristic of a scalar quantity is that it is possible to specify it completely by a simple number. On the other hand, the magnetic force at any point, the velocity of a moving body, the magnetic induction at any point of a mass of iron, are examples of *vector* quantities, and something more than a single number is required to specify them completely. Thus, if we take magnetic force, a single number would merely tell us what the intensity of the force is, without, however, informing us as to the *direction* in which it acts. Vector quantities, then, are quantities having direction in space. Now, direction may be represented by a straight line drawn in space. This at once suggests that we may make use of straight lines to represent vector quantities. The direction of a vector quantity is represented by a straight line with an *arrow-head* affixed to it. Further, the *magnitude* of a vector quantity is easily represented to any convenient scale by the *length* of a line, so that we have a method of representing vector quantities completely (both as regards magnitude and direction) by straight lines of definite length with arrow-heads attached to them.

Thus, let O A (Fig. 7) be a straight line of length 10, and let us suppose that it represents the magnetic force at the point O. The direction of the force is indicated by the direction of the line O A and its arrow-head. The magnitude

* Based on a series of evening lectures delivered at the University College, Liverpool.

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of the force is 10, if we suppose each unit of length to correspond to a unit force. The force is therefore completely specified by the straight line O A.

Vector quantities are frequently, for the sake of brevity, termed *vectors* simply, and the same term is applied to the lines representing them. In what follows, we shall frequently apply the term "vector" to denote a straight line of definite length, with an arrow-head at one end of it.

10. Hitherto we have regarded vectors (in the sense last named) as representing certain *quantities*. But there is another way of looking at them which is very instructive, and which will enable us easily to deduce some important results concerning them. We may, in fact, regard a vector as an *operator*, and the operation which we suppose it capable of performing is that of transferring a point from a given position in space to another position, through a distance equal to that of the vector, and in a direction parallel to it. Thus, the result of applying the vector O A (Fig. 7) to the point P is to transfer the point from P to P′, where P′ is such that P P′ is equal and parallel to O A.

It may be as well at this stage to draw the student's attention to the fact that when a vector is denoted by two letters, such as O A in Fig. 7, the last letter always refers to the extremity of the vector to which the arrow-head is attached. Hence A O would denote a vector parallel and equal in length to O A, but with its arrow-head pointing in the opposite direction, as shown by the dotted line A′ O′ in Fig. 7.

Let us apply the vector O A to the point P; this will transfer P to P′. Next, let the vector A O be applied to P′. This will bring P′ back to its original position P. Thus the successive application of the two vectors O A and A O produces no resultant effect. Hence we may write $\overline{OA} + \overline{AO} = 0$, or $\overline{OA} = -\overline{AO}$, where the bar above the letters is used to indicate that they denote vectors, and not mere lengths.

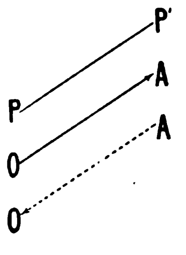

FIG. 7.

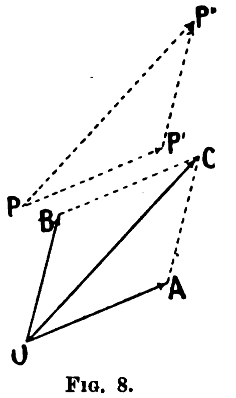

FIG. 8.

11. We may now consider the result of applying any two vectors, O A and O B (Fig. 8), to a given point P. Applying first the vector O A, we transfer P to P′, where $\overline{PP'} = \overline{OA}$; next, applying O B, we transfer P′ to P″, where $\overline{P'P''} = \overline{OB}$. The final result, then, is to transfer P to P″. But this might have been accomplished more simply by at once transferring P to P″ along the straight line P P″. Now $\overline{PP''} = \overline{OC}$, the diagonal of the parallelogram constructed on O A and O B as sides. We thus have $\overline{OA} + \overline{OB} = \overline{OC}$, a result which is generally referred to as the *parallelogram law* for the addition of vectors. Again, we have $\overline{PP'} + \overline{P'P''} = \overline{PP''}$. This result is sometimes spoken of as the *triangle of vectors*.

It will, of course, at once be seen that the above result only applies to the lines O A, O B, etc., when these are *considered as vectors*, and not as mere lengths, in which latter case it obviously does not hold.

The law of addition just established for two vectors may be extended to any number of vectors. Thus, let $\overline{OA}$, $\overline{OB}$, and $\overline{OC}$ (Fig. 9) be applied to the point P in succession. The result is to transfer P to P‴ along P P′ P″ P‴. The same result is obtained by the direct application of the single vector P P‴. We thus have $\overline{PP'} + \overline{P'P''} + \overline{P''P'''} = \overline{PP'''}$, a result known as the *polygon of vectors*.

The law established above for the composition of vectors at once provides us with a method for finding the resultant of any number of vector quantities. We thus have the triangle (or parallelogram) and polygon of velocities accelerations, forces, etc.

12. From what has already been said regarding projection (Art. 6), it will be understood that the projection of a vector on a given straight line is equal to the product of the vector into the cosine of its angle of inclination. Also, the sum of the projections of any two vectors is equal to the projection of their resultant.

13. We now proceed to the study of certain kinds of motion which will be found to be of very great importance in connection with our subject. The two motions which we shall have to consider are known as *uniform circular motion* and *simple harmonic motion* respectively.

Let a point P (Fig. 10), starting from the position A, move with *constant speed* round the circumference of the circle A B C D in a counter-clockwise direction. The motion of P is said to be *uniform circular motion*. As P moves along the circumference of the circle, the radius O P traces out the angle A O P, which increases at a constant rate. The amount by which the angle A O P increases in a unit of time is termed the *angular velocity* of O P. Angular velocity is commonly expressed in *radians per second* (Art. 2). Let us suppose that the angular velocity of O P is p, and let v stand for the speed of P. Then, since the length of arc described by P in one second is v, and the radius of the circle is equal to O P, the angle swept out by O P in one second is $\frac{v}{OP}$; but this is, by definition, the angular velocity of O P—*i.e.*, p. Hence,

$$p = \frac{v}{OP}, \text{ or } v = p \cdot OP \quad . \quad . \quad . \quad (11)$$

i.e., the speed of P is obtained by multiplying the angular velocity by the radius of the circle.

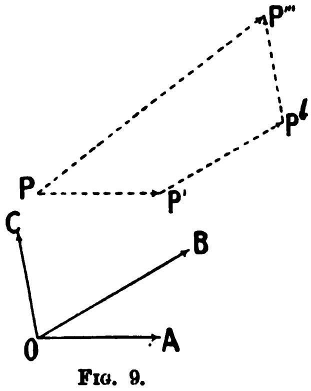

FIG. 9.

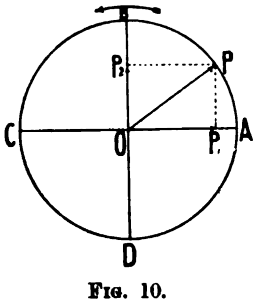

FIG. 10.

14. Consider the projection of P (Fig. 10) on any fixed straight line, such as the horizontal diameter C A of the circle. Let P_1 denote the projection of P on this diameter. As P moves round the circumference of the circle its projection P_1 *oscillates* to and fro along the diameter C A. This oscillatory motion of P_1 is called a *simple harmonic motion*. We thus define *simple harmonic motion* as the *projection on any fixed straight line of uniform motion in a circle*. Every simple harmonic motion must therefore be capable of being referred to a corresponding uniform motion in a circle, and this circle is termed the *auxiliary* circle.

The time of a complete revolution in the auxiliary circle is called the *periodic time*, or simply the *period*, of the simple harmonic motion.

The radius of the auxiliary circle is termed the *amplitude* of the simple harmonic motion.

15. The two motions which we have just considered may be represented by means of two vectors as follows. Uniform circular motion may be expressed by a vector of constant length, one of whose extremities is fixed, while the other moves round the circumference of a circle with constant speed. Simple harmonic motion may be represented by another vector, which is the projection, on a fixed straight line, of the first vector. Following Prof. Galileo Ferraris, we shall call the first vector a *rotating vector* and the second an *alternating vector*. A rotating vector is constant in length, but variable in direction; an alternating vector is variable

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in length, but its direction is always along the same straight line.

Consider two alternating vectors of the same period. At any instant, the alternating vectors will be inclined at certain angles to their corresponding rotating vectors. If the two angles are equal we say that the two alternating vectors are in the same *phase*; if the angles are different the constant difference between them is called the *difference of phase* between the two alternating vectors.

16. We shall now obtain an algebraical expression for an alternating vector. If we suppose that the line in which the alternating vector lies is given, its length at any instant may be expressed by a number, with the *plus* or *minus* sign attached to it. In accordance with the convention regarding signs (Art. 1), a plus sign indicates that the vector has its arrow-head pointing in one direction, a minus sign that it is pointing in the opposite direction. Referring to Fig. 10, let us suppose that a rotating vector O P, of length R, starts from the position O A, and moves round with angular velocity p. Let A O P be the angle swept out in t seconds. Then A O P $= p\,t$. Consider the alternating vector O P_1 obtained by projecting O P on the horizontal diameter. Let $r_1 = \mathrm{O\,P_1}$. Then

$$r_1 = \mathrm{O\,P_1} = \mathrm{O\,P} \cos \mathrm{A\,O\,P};$$
$$= \mathrm{R} \cos p\,t \quad . \quad . \quad . \quad . \quad . \quad (12)$$

Again, consider the alternating vector O $P_2 = r_2$, obtained by projecting O P on the vertical diameter. We have

$$r_2 = \mathrm{O\,P_2} = \mathrm{O\,P} \cos \mathrm{B\,O\,P};$$
$$= \mathrm{O\,P} \sin \mathrm{A\,O\,P}, \text{ by (5)}$$
$$= \mathrm{R} \sin p\,t \quad . \quad . \quad . \quad . \quad . \quad (13)$$

From (12) and (13) we see that an alternating vector may be expressed as the product of two quantities, one of which (R) is a constant, while the other is the *sine or cosine of an angle which varies at a constant rate with the time.*

will be an alternating vector. We have thus established the following proposition:

The resultant of two alternating vectors of the same period and in the same straight line is another alternating vector, also of the same period and in the same straight line.

A glance at Fig. 11 also reveals the fact that the resultant vector is intermediate in phase between its two components.

19. We shall next obtain an algebraical expression for the resultant of the two vectors. Let us suppose that at the commencement the rotating vector O A occupies the position O P. After time t, it will have swept out an angle P O A $= p\,t$, if p stand for the angular velocity. Calling the angle A O B between the two rotating vectors θ, we see that at time t the vector O B makes an angle P O B with the horizontal axis equal to $p\,t + \theta$. Denoting the lengths of O A and O B by A and B respectively, and projecting on the vertical axis, we find

$$\mathrm{O\,A_2} = \mathrm{A} \sin p\,t,$$

and $\mathrm{O\,B_2} = \mathrm{B} \sin (p\,t + \theta) = \mathrm{B} \sin p\,t \cos \theta + \mathrm{B} \cos p\,t \sin \theta$, by (8).

The resultant of these two vectors is obtained by projecting O C on the vertical axis. Denoting the angle A O C by a, and the length of O C by C, we get

$$\mathrm{O\,C_2} = \mathrm{C} \sin (p\,t + a),$$
$$= \mathrm{C} \sin p\,t \cos a + \mathrm{C} \cos p\,t \sin a, \text{ by (8).}$$

Now we have $\mathrm{O\,C_2} = \mathrm{O\,A_2} + \mathrm{O\,B_2}$—*i.e.*,

$$\mathrm{C} \cos a \,.\, \sin p\,t + \mathrm{C} \sin a \,.\, \cos p\,t$$
$$= (\mathrm{A} + \mathrm{B} \cos \theta) \,.\, \sin p\,t + \mathrm{B} \sin \theta \,.\, \cos p\,t.$$

Comparing coefficients of $\sin p\,t$ and $\cos p\,t$ on both sides, we see that

$$\mathrm{C} \cos a = \mathrm{A} + \mathrm{B} \cos \theta \quad . \quad . \quad . \quad (14)$$

and

$$\mathrm{C} \sin a = \mathrm{B} \sin \theta \quad . \quad . \quad . \quad . \quad . \quad (15)$$

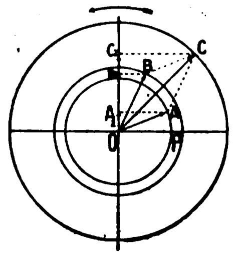

FIG 11.

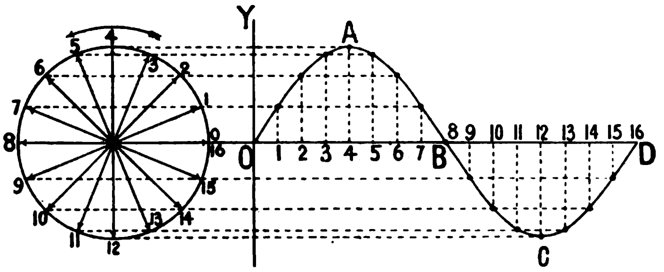

FIG. 12.

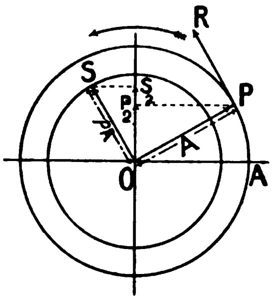

FIG. 13.

17. In order to express the *period* T of an alternating vector in terms of the angular velocity p, we have merely to notice that the angle described by the rotating vector in one period is $2\,\pi$ (*i.e.*, four right angles). Hence $p\,\mathrm{T} = 2\,\pi$, so that $\mathrm{T} = \frac{2\,\pi}{p}$. Also, if n stand for the number of complete periods per second, we have $\mathrm{T} = \frac{1}{n}$; hence $p = 2\,\pi\,n$.

18. We are now in a position to consider the problem of finding the resultant of two alternating vectors in the same straight line and of the same period. Let O A and O B (Fig. 11) represent the two rotating vectors from which the alternating vectors are derived. Since the two vectors are of the same period, O A and O B will revolve round O with the same angular velocity, so that the angle A O B between them will remain unaltered. This angle is termed the *angle of phase difference* between the two vectors (Art. 15); we may otherwise express this by saying that the alternating vector derived from O A *lags* behind that derived from O B, and that A O B is the *angle of lag*. Let us suppose that the alternating vectors are obtained by projecting the rotating vectors on the vertical axis. At any instant the *resultant* of the two alternating vectors is the sum of the projections of O A and O B on the vertical axis; but (Art. 12) this is the same as the projection of O C, the diagonal of the parallelogram constructed on O A and O B as sides. Now since the angle A O B remains constant, O C will remain of constant length, and will revolve about O with the same constant angular velocity as either of the two vectors O A and O B. Hence O C will be a *rotating* vector, and therefore its projection on the vertical axis

Dividing (15) by (14), we get

$$\tan a = \frac{\mathrm{B} \sin \theta}{\mathrm{A} + \mathrm{B} \cos \theta} \quad . \quad . \quad . \quad (16)$$

Squaring (14) and (15), adding, and remembering that $\cos^2 a + \sin^2 a = 1$, we get

$$\mathrm{C}^2 = \mathrm{A}^2 + \mathrm{B}^2 + 2\,\mathrm{A\,B} \cos \theta,$$

or

$$\mathrm{C} = \sqrt{\mathrm{A}^2 + \mathrm{B}^2 + 2\,\mathrm{A\,B} \cos \theta}.$$

We therefore have this result—

$$\mathrm{A} \sin p\,t + \mathrm{B} \sin (p\,t + \theta)$$
$$= \sqrt{\mathrm{A}^2 + \mathrm{B}^2 + 2\,\mathrm{A\,B} \cos \theta} \times \sin (p\,t + a),$$

where a is determined by equation (16).

20. The variations of an alternating vector with the time may be represented graphically by plotting a curve whose abscissæ correspond to time, and whose ordinates represent the corresponding instantaneous values of the alternating vector. This is easily done by the method shown in Fig. 12. Let the circle represent the path of the moving extremity of a rotating vector, and let O D and O Y be the two co-ordinate axes. Divide the circumference into any convenient number of *equal* parts. Since the rotating vector moves with constant angular velocity, each division of the circumference will correspond to the same interval of time. Along the time-axis O D lay off a number of equal lengths, O 1, 12, 23, etc. Let each of these divisions represent a time-interval equal to that corresponding to one division of the circumference. Through the points of division on the circumference draw lines parallel to the axis of time; the intersections of these lines with the corresponding perpendiculars drawn through the points 1, 2, 3, etc., on the time-

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axis obviously determine a number of points on the curve required, since the instantaneous values of the alternating vector are determined by projecting the rotating vector on the vertical axis. By drawing a continuous curve through the points so determined we obtain the curve O A B C D, which shows at a glance the way in which the alternating vector varies as time goes on. The time-interval represented by the length O D is obviously equal to the period.

21. Every alternating vector, as we have seen, is capable of being exhibited as the product of two factors, one of which is a certain constant quantity (the *amplitude* of the vector), and the other the sine of an angle which varies at a constant rate as time goes on (Art. 16). Hence the curve O A B C D really represents the variations in the sine of an angle as the angle is varied, the values of the sine being, however, multiplied by the amplitude of the vector. Now, if we multiply each ordinate of a curve by a constant quantity, we merely alter the *scale* of the vertical axis without altering the character of the curve. Hence all such curves as O A B C D are called *sine curves*, or *simple harmonic* curves. One of the characteristics of such curves is that any one of them is capable of being transformed into any other by merely altering the horizontal and vertical scales of the diagram.

22. Any function of the time which is capable of being represented by an alternating vector is termed a *sine* function, or a *simple harmonic* function, of the time. If, for example, we speak of an alternating E.M.F. as being a sine function of the time, we thereby mean that it varies as time goes on according to the law represented by the curve O A B C D in Fig. 12.

In what follows we shall frequently have to deal with the *rate of change of an alternating vector*. In Article 7 it was explained that if we suppose the graph of a function to be recorded by a tracing point, the rate of change of the function *at any instant* is represented by the velocity of the projection of the tracing point on the vertical axis. Referring to Fig. 13, let O P represent a rotating vector of length A, and angular velocity p. Its projection O P_2 on the vertical axis at any instant gives us an alternating vector, whose rate of change *at the same instant* is represented by the velocity of its extremity P_2. Now the velocity P R of P is, by Article 13, equal to p A. From O draw a line O S equal and parallel to P R. Then O S represents the velocity of P at the instant considered, and hence the velocity of P_2, the projection of P, will be obtained by projecting O S on the vertical axis. Thus O S_2 gives us the rate of change of the alternating vector at the instant when the latter has the value O P_2, and is increasing. Now since the speed p A of the point P remains constant, O S will be a vector of constant length = p A. Also, since O S is always at right angles to O P, O S will revolve round O with constant angular velocity p—*i.e.*, O S will be a rotating vector, and therefore its projection O S_2 on the vertical axis will be an alternating vector. We thus arrive at the following proposition, which is of very great importance:

The rate of change of an alternating vector of amplitude A and period $\frac{2\pi}{p}$ *(Art. 17) is represented by another alternating vector of the same period, and of amplitude p A, this vector being* $\frac{\pi}{2}$ *(one right angle) in advance of the given vector as regards phase.*

Thus, if we have an alternating vector

$$A \sin p t,$$

its rate of change is represented by the alternating vector,

$$p A \sin \left(p t + \frac{\pi}{2}\right).$$

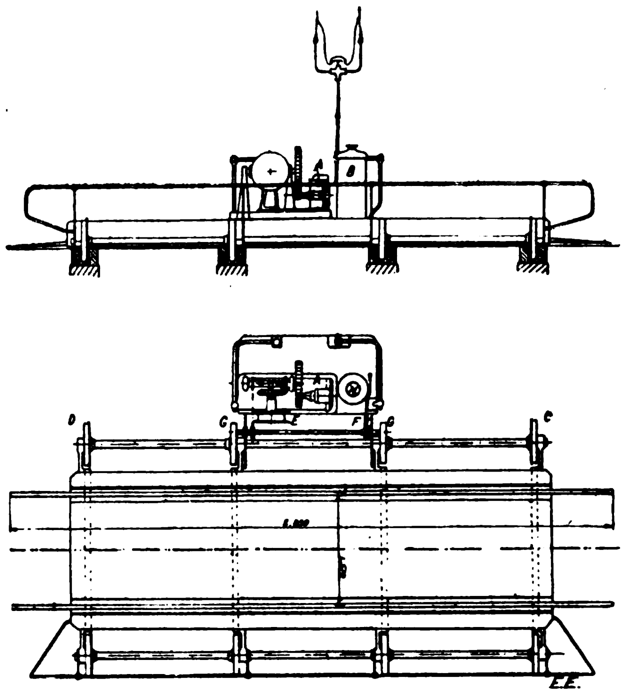
This result may otherwise be expressed thus: the rate of change of a given sine function is represented by another sine function, which is one-quarter of a period in advance of the given function.

In concluding this introductory part of our subject it may be well once more to insist on the extreme importance of the propositions which have just been established. Unless the student has thoroughly mastered them and acquired a clear understanding of what is meant by the *rate of change* of a varying quantity, he cannot hope to make much progress in the study of the principles which underlie alternate-current working.

(To be continued.)

A TRAVELLING PLATFORM FOR RAILWAY WORK.*

The Administration of State Railways at Saintes have just made an interesting application of electricity to the working of surface travellers for shifting railway carriages and wagons in the erecting shop. The traveller runs on small roller wheels, and no pit is necessary. A 3·044-kilowatt motor for 900 revolutions (A, Figs. 1 and 2) is geared by a toothed wheel and pinion to a horizontal axle.



FIGS. 1 AND 2.

This drives by bevel gear a vertical shaft carrying a windlass for hauling on the wagons and also gearing with the rollers, G (see Fig. 2), of the traveller. The current from a dynamo at the works generating station is taken to the motor and back by two overhead wires with rubbing trolleys. The voltage is 110. Carbon brushes are used on the motor without any lead, so that reversal of the direction of travel is obtained by changing the direction of the armature current, and speed regulation is obtained by similar means. The rate of travel when empty is 34 metres (37 yards) per minute, and with a load of 15 tons, 27 metres (29¼ yards). The maximum

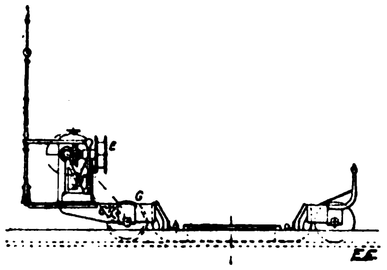


FIG. 3.

speed for hauling the carriages up to the traveller is 75 metres (over 81 yards) per minute. The electrical part of the work has been done by the Société des anciens établissements Cail, and five of the apparatus have been ordered. The cost of each, for the mechanical and electrical part only, is 3,500fr. (about £140), but railwork and adjustment and locking apparatus bring this up to a total of 4,300fr. (£172). At Saintes the current for working is conveyed a distance of 434 metres (470 yards). It is stated that the apparatus has given great satisfaction in use. The starts and stoppages are made with ease and accuracy, and only two men are required for working—one at the motor and one to couple the carriages.

* From an article by G. Baignères in *L'Electricien.*

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ALTERNATE-CURRENT MOTORS.

The need of a good alternate-current motor for use on the public supply mains has been often referred to in our columns. We have felt that the motors supplied by the Continental makers have not given complete satisfaction either to the consumer or to the central-station engineer. The requirements of the consumer in many respects are antagonistic to the comfort of the central-station engineer. Thus the consumer may require a motor with a good starting torque, and while the engineer is only too pleased to fill in the great depressions in his load curve, he objects to the pressure on his mains being upset whenever a motor is switched on. The aim of the Continental makers of single-phase alternate-current motors has been to prevent such disturbance by suitable starting gear. Again, the user of an electric motor demands that it shall have a high efficiency, and if his meter only registers watts the power factor of the motor does not affect him. This power factor is of great importance to the central-station engineer, as the drop of voltage due to current and self-induction effects in the mains is largely increased by a decrease in the power factor. We are exceedingly glad to see that the design and manufacture of motors to work on alternate-current systems is being taken up in our own country. Mr. Langdon Davies has, we believe, devoted much care and original thought to the subject, and may be congratulated on the results of his efforts. We were privileged to see some of his motors at work recently. In the limited time then at our disposal we had every convenience given us for examining their qualities. From the rough tests thus made, we gather that a good motor has been produced of which its designer may be justly proud, but we disagree with the expert report now being used to recommend this motor to the public. In this report, which we print in full in the present issue, an efficiency of over 96 per cent. is claimed for a three-quarter horse-power motor. Such an abnormally high result is quite sufficient to show that some fault must exist in the testing apparatus. The electrical and magnetic losses in an alternate-current motor can be fairly compared with those in a transformer. Any difference would certainly be in favour of the latter. A transformer of three and a quarter horse-power having over 90 per cent. efficiency at half-load is rarely, if ever, met with in practice. Yet for this motor, in which bearing friction and mechanical losses are also found, the expert in question does not hesitate to claim such a result. It would be absurd to attempt to point out where the flaw in the test has occurred, but we would suggest that the readings of the wattmeter might be improved upon. The true watts calculated from these readings are given in four significant figures, while the readings themselves appear to have at the most an accuracy of 5 per cent. This remarkable wattmeter also shows that when the brake is loaded with two pounds, the addition of another pound, while it increases the brake horse-power, it decreases the watts given to the motor. The same wonderful absence of fractions can be seen to a smaller extent in the ampere readings. Half a

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division in fifteen is the very least fraction recorded in the set of readings, while readings for the current under practically constant load vary by as much as 7 per cent. Assuming these instruments to be correctly calibrated, the recorded readings might lead one to expect such discrepancies as are found between the different efficiencies with a given load on the brake. This does not account, however, for the high efficiency prevailing throughout. Leaving the table of observations, and coming to the report itself, we find a general commendation of the motors running throughout, and accompanied by a lack of facts. Thus we are assured that in starting torque the motor is far above all its rivals, but we look in vain for any hint of the fact that this starting torque is only obtained by an abnormally large current. That the central-station engineers would debar the use of a motor on their systems which took more than five times its normal current when starting is extremely probable. Yet we find no hint that to obtain one-quarter of the full-load torque—not one-half, as stated in error in the report—the current required would exceed the above limit. Again, although perhaps it is too small a point to be worthy of the expert's notice, we find no comparative brake test with the common Prony brake, and the general public is not told that the Raffard brake puts a purely torsional strain on the motor shaft. These motors, with the frequency common in English stations, give too high a speed for direct coupling to anything but very small fans, and generally will drive by belts. The working conditions will thus give a side strain on the bearing, which at the high speed will materially alter the efficiency. The general conclusion of the expert at the commencement of his report states that the motors are worked on the same principle as the two and three phase motors, which gives to them the advantages of such polyphase systems. He adds, "it has long been known that these advantages could be in degree realised by the device known as 'splitting the phase' of the current, but this device has never hitherto been used to the best advantage. As a result, the motors are of higher efficiency, and start on load more readily than any other alternate-current motors of equal output." These statements are most misleading. The phase-splitting device is only used in starting, and its effect increases the starting current to a prohibitive amount, so that the resistance method of phase splitting has been generally abandoned. The so-called "advantageous phase splitting," not being in use when the motor is loaded, cannot influence the efficiency, and yet the expert does not hesitate to publish figures showing efficiency higher than any obtained with multiphase motors, and 30 per cent. higher than those from any single-phase motor of the same output previously on the market. That such an enormous stride can be made off-hand is most highly improbable in the present advanced state of the industry. We would go as far as to say that it is a physical impossibility, with the present material at our command, to make a single-phase motor having the efficiencies claimed. We regret to have to call attention to this report so strongly, but its wide distribution and general acceptance among the technical and non-technical Press leaves us no option.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

STREET TRAFFIC AND MOTOR VEHICLES.

SIR,—The congested state of our streets frequently attracts attention, and has lately been commented upon in several of the daily papers. It is a well-known fact that the traffic in the City streets is becoming every year more difficult to cope with, and that some further means than have been devised are necessary for its relief is evident.

I am of opinion, with others who have studied this subject, that the introduction of mechanically-propelled vehicles will greatly reduce the pressure in our streets. It cannot, of course, be expected that this mode of locomotion will be adopted immediately. It will be many years before its use becomes general, but the due appreciation of the benefits to follow will certainly accelerate the desired result.

The mechanical vehicle has the following advantages over that drawn by horses: it can turn the sharpest corner with ease; it can be started and stopped in shorter time and distance, and can turn in the street without blocking the traffic, owing to less space being required; it is more perfectly under control, and can be steered more accurately than a horse carriage. The straining efforts of horses to start a heavy load when the roadway is at all slippery are often painful to passers-by, and fallen horses daily cause confusion in our streets.

The control of the traffic will be far simpler when motor vehicles are in every-day use, and the dangers in the streets will be considerably lessened. Should a motor carriage be disabled, it could be withdrawn from the main traffic with far greater ease than is the case with a fallen horse. I do not mean to infer by these remarks that horses will ever be entirely dispensed with, but we shall not see so many of the poor and overworked horses now so common.

I may suggest that an examination might be instituted, and an expert appointed to grant certificates to those qualified to drive motor vehicles; these certificates to be carried and produced by the driver whenever required by the police.—Yours, etc.,

F. J. WARDEN-STEVENS.

NORTHAMPTON INSTITUTE.

Through the courtesy of the principal, Mr. R. Mullineux Walmsley, we had on Wednesday an opportunity of seeing the buildings of the Northampton Institute in their present state. Mr. Walmsley kindly explained to us the history of the scheme for the building and equipment of this new teaching and recreative institute in Clerkenwell. The institute forms a part of the City polytechnic scheme, which includes in its range the Birkbeck Institute and the City of London College. Both these institutions are largely connected with the South Kensington system of education and also with the preparation of students for the London degrees. It was therefore laid down as a *sine quâ non* that the Northampton Institute should not encroach upon this work, hence the courses of instruction given there under Mr. Walmsley's able superintendence will be of a purely technical character. There is also a well-arranged social and recreative side to the institute, which will be highly appreciated in the district. The part of the building devoted to this purpose was informally opened on Saturday last. The portion of the building devoted to educational work has been delayed owing to some difficulty in obtaining possession of the whole of the site.

The land upon which the institution is to be built was given by the Marquis of Northampton, and consists of about 1¼ acres. The value of the munificent gift is estimated at something like £30,000. The funds for the building were provided by the City Parochial Charity, assisted by

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the Skinners' Company and the Saddlers' Company, the first named body provided the bulk of the money, while the Skinners' Company contributed £5,000. The institute has been further started with a handsome endowment fund, providing about £5,000 per annum. Of this amount the major part has been provided by the City Charities, while the Skinners' Company have guaranteed £1,000 per annum and the Saddlers' Company have handed over to the institute the proceeds of the Ritchen Charities, which are estimated to realise about £500 per annum. The governors of the institute consist of representatives of the above donors, and they have power to choose a certain number of additional members to co-operate with them. The County Council will also be represented in time, when grants are received from it.

Mr. Walmsley intends to organise the educational scheme so as to be in touch with the numerous industries of the Clerkenwell district. Hence watchmaking will take a very considerable place in the programme, and leading arts connected with the design of watches and clocks will be carefully provided for. In the arts department such subjects as engraving and setting of precious stones, etc., will be included in the usual courses. In the engineering and physical department a general knowledge will be given, the aim of the institute being rather to supplement the knowledge of those engaged in industry than to turn out artisans specially skilled in any one branch of work. In this way Mr. Walmsley hopes to combat the tendency to convert men into machines, which is the result of the modern system of extreme sub-division of labour. We were informed that previous efforts in the technical training in watchmaking elsewhere had not been so successful owing to the opposite aim being followed. We agreed entirely with Mr. Walmsley when he stated that no institute could hope to give the training derived from daily work at the trade, and that the subject of technical education should be rather to train men to use their brains when working. The buildings as yet are hardly in sufficiently advanced stage to be described, but the parts completed to the designs of the architect, Mr. E. W. Mountford, show great attention to the convenience and safety of the members. The large hall, capable of holding comfortably some 1,500 people, is practically completed. The exits from it have been most carefully arranged so that the audience can leave the hall without danger should a panic arise. The gymnasium is also completed and equipped. This branch is under the superintendence of Prof. Oberholyer, of the German Gymnasium. The part of the institution devoted to teaching is, as stated above, in too backward a state to enable Mr. Walmsley to complete his arrangements for its outfit. Some rough idea of the large machinery can, however, be obtained. Two boilers of equal steaming capacity are being erected—one of the water-tube type, and the other a Lancashire. Complete arrangements for feed-heating, economisers, and superheaters will be added, so that comparative tests can be made with and without these economic adjuncts. In the engine-room a Willans and Robinson 100-h.p. engine will be erected, and coupled direct to a 75-h.p. Castle dynamo, by Messrs. J. H. Holmes and Co. Mr. Walmsley hopes to add a horizontal engine of the same power driving by ropes another dynamo. In this way a large amount of combined tests can be carried out.

We hope at a later date to be able to give a full detailed account of this institution.

ELECTRIC TRACTION.

Among the papers read at the annual meeting of the Association of Municipal and County Engineers at Brighton last week was one by Mr. R St. George Moore on this subject, which we give herewith. The paper was taken on Friday morning, and a very interesting discussion followed. In our issue of November 8 last we published illustrations of the Brighton and Rottingdean electric railway (which was referred to by Mr. Moore) showing sections of track, details of trolley pole connections, and a side elevation of the car.

Electric Traction: A Review of its Application and a Comparison with other Methods.

BY R. ST. GEORGE MOORE, M.I.C.E.

A civil engineer acting either for a corporation or in general practice has frequently to advise on matters about which it is an absolute impossibility for him to be conversant with all the details. For instance, in the preparation of waterworks scheme he has to decide upon the type of pumping machinery to be adopted; whereas it would be unwise for him to attempt to design the machinery, knowing as we do that all machinery such as marine engines, pumping engines, etc., have been brought to their present condition by the makers of the various types gradually introducing improvement upon improvement. The same case will apply to traction. It would, in the first instance, probably devolve upon the civil engineer to decide whether electrical or some other method of traction should be adopted, his knowledge of the nature of the traffic to be carried, the nature of the permanent way, the grades and curves being essential to come to a proper decision. When this decision has been arrived at, then the detail ought to be put into the hands of one of those who have made the method of traction selected their speciality. The author's object, therefore, in this paper is to consider electric traction, not from an electrical engineer's point of view, but from a civil engineer's, and to describe a few of the leading and most instructive examples and analyse their merits or demerits. The following lines have been selected for description as illustrating the distinctive features of electric traction : (1) the Brighton Electric Railway; (2) street railways; (3) the Liverpool Overhead; (4) Brighton and Rottingdean Sea-shore Electric Tramroad.

Brighton Electric Railway.—The Brighton Electric Railway is described first, as being the pioneer electric railway in the United Kingdom and Ireland, having been opened by the Mayor of Brighton on August 2, 1883, the next being that at the Giant's Causeway in Ireland, which was opened in November of the same year. Further, because it is one of the best exponents of the application of electric traction on a small scale. The line commences opposite to the entrance to the Aquarium, and runs for a distance of about a quarter of a mile principally on wooden tressel work placed on the outside of the sea-wall, so that in rough weather the main frame and working portions are open to the salt-water spray, which would be a serious drawback to any other method of traction. The line passes under the Chain Pier and along the top of the beach to the terminus at Paston-place, a total distance of about one mile, the steepest gradient being on the east side of the Chain Pier, which is 1 in 14. The electricity is supplied from a generating station at Paston-place, the prime mover being a 20 nominal horse-power gas-engine. The power is conveyed from the central station to the cars by a third rail. The cars weigh complete with motor and gear, but exclusive of passengers, 1¼ and 1¾ tons; and when fully loaded, 3¼ and 4 tons. With the above plant four cars can be kept running at the same time at (if required) 14 miles per hour, at a total average cost of 4d. per car mile. This includes depreciation and repairs, but not interest on capital.

Street Railways or Tramways.—The principal application of electric traction has been its substitution for horse traction on street railways or tramways, as exemplified by those in Dublin, Hamburg, Brussels, and Bristol, and a large number of other towns, one company in America having a total length of road of 272 miles and 1,705 motorcars. The initial difficulty of the application of electricity to tramways was the distribution of the motive power. Two methods have at various times and places been adopted—first, the conductor in a conduit; second, the overhead wire or trolley system. The first consists of a copper or iron conductor carried on insulators, as in the third-rail system, but placed below the surface of the road and protected by an iron casing with a slot in the top, through which slot contact is formed. This system has never been extensively used. The drawbacks to it are its expense, its being liable to get filled with water and mud, and the width of the slot at points and crossings being a great disadvantage to wheel traffic. The system which has been most universally adopted, there being about 10,000 miles working with this system in America and 1,000 miles in Europe, consists of an overhead conductor, generally a copper wire, suspended on poles similar to telegraph wires, but of course very much heavier. In England, considerable objection is raised to this system on account of the danger to the traffic from a falling wire and the unsightliness of the poles. The author considers that the value of these objections has been considerably over-estimated—the danger from the wire being reduced to a minimum by care and attention, and the poles now being made an ornament rather than an eyesore. [By the kindness of Mr. Philip Dawson, illustrations of the poles used at Dublin and Bristol, together with several specimens of trolleys and insulators, were shown.] The poles illustrated are manufactured in America, English makers not having as yet adopted any good system for making the joints between the varying diameters of the tubing, the adopted test for which

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s that the pole is to be lifted 6ft. and allowed to fall free, when if any of the joints have telescoped the pole is rejected.

Permanent Way.—If electric traction is adopted in preference to cable or horse traction greater attention must be given to the permanent way, because of the greater weight of a motorcar than an ordinary tramcar, or of one for a cable road, and also because of the motor being a delicate instrument to which violent shocks are detrimental. The Americans are using rails as heavy as 100lb. per yard, with welded instead of fishplate joints, but when there is a good foundation the author is of opinion a lighter section is admissible. Steep gradients are no detriment to electric traction by motorcars. In the United States they have been made to work up to 1 in 7. If a locomotive is employed the dead-weight has to be carried to produce adhesion, whereas with the motorcar the car and passengers are the weight-producing adhesion. The Dublin electric tramway system, which was opened on May 16 last, commences near the centre of Dublin and runs to Dalkey, a distance of 7¾ miles. The heaviest gradient is 1 in 16. The rails are of the ordinary girder type, weighing 76lb. per yard, and the gauge is 5ft. 2 3-16in. The trolley system has been adopted; the overhead wire conductor is carried for the greater portion of the distance by means of span wires stretched across the streets; a small portion is carried by the double-bracket poles shown. The peculiarity of this installation is that electricity of various pressures is generated at the central station at Ballsbridge. The lower pressure is conveyed direct to the conductor, from which the car draws its supply, and the higher to one or other of the two sub-stations, where it is reduced in pressure and supplied to another section of the line. The sub-stations are at Blackrock and Dalkey, the object of this being to save loss by leakage and cost in the conductor; a small conductor being capable of conveying the same power at a high pressure as a larger one can at a low pressure, also to enable them to maintain the pressure required by the Board of Trade in the return current.

The Liverpool Overhead Railway.—This railway runs for a distance of about seven miles along the inside of the docks at Liverpool; it is carried for nearly the whole of its length on an iron viaduct. There are 15 stations, averaging about 900 yards apart. Each train consists of two motor carriages, seating together 114 passengers, and weighing, including passengers, 38 to 40 tons. The train service is every five minutes, and there are 12 trains either starting, travelling, stopping, or at rest, all being actuated from the prime mover situated in the central generating station. There is one short gradient of 1 in 40, and the sharpest curve is seven chains. Mr. Parker, in his paper read before the Institution of Civil Engineers, gives the cost to be between 3·441d. and 4·075d. per car mile, with about 40,000 car miles per month. This line and its electrical equipment is very fully described in the papers by Messrs. Greathead, Fox, and Parker, vol. cxvii. of the *Minutes of Proceedings* of the Institution of Civil Engineers.

Brighton and Rottingdean Seashore Electric Tramroad.—This line is one of the latest and most peculiar applications of electric traction. Before describing the reasons for adopting electric traction it will be necessary to give a brief description of the line. This line is situated on the foreshore entirely between high and low water, and extends from the Paston-place groyne within the borough of Brighton to Rottingdean—a distance of two miles seven furlongs. At high water of spring tides, at the deepest portion of the line, the car will run in 15ft. of water—that is to say, the rail-level will be 15ft. below water-level. The permanent way consists of four lines of 52lb. steel flange rails, specially rolled with an additional width of flange and thickness of web to compensate for the corrosion which will take place, and thereby equalise the life of these portions with the rail-head, the life of which, it is anticipated, will be considerable owing to the comparatively small amount of traffic to which it will be subjected. The rails are laid in pairs to a gauge of 2ft. 8½in., and to a total gauge between the outer rails of 18ft. The sleepers of ordinary railway practice are substituted by concrete blocks and large cast-iron chairs, according to the nature of the ground. Between the rails and the cast-iron chairs and the concrete blocks oak cushions are fixed. Where concrete blocks are used mortises are cut so as to be at least 6in. into the solid chalk, and a box framed round it of the height required, and the block formed by filling the box with concrete. Although some portion of the line has been completed two winters, after the concrete has once had time to set no damage has been done to the blocks, either by the sea or frost. As may readily be understood, a large amount of trouble was caused by rough weather damaging the blocks in their green state. The precedent for the use of concrete sleepers was the favourable results obtained for slow traffic by the Würtemberg States Railway prior to the general adoption in Germany of steel or iron sleepers. The cast-iron chairs are similarly fixed, with the exception that the mortises are deeper, and where the chair stands more than 2ft. out of the ground a concrete plinth is built round it. The rails and oak cushions are fastened to the concrete blocks by two bolts built into the block during construction. The ruling grade is 1 in 300, and 40-chain curves (with the exception of one very short piece of curve near the Paston-place station) have been adopted. The stations at Paston-place and Rottingdean are small piers or jetties constructed in iron, with a deck level with the deck of the car, or about 23ft. above rail-level.

The car is carried on 16 33in. wheels in four bogies, two of which occupy each line of road, and are held in position by a strong steel tube framing. On each bogie stands a main steel tube column, from which spring the arched girders supporting the deck. The level of the deck is 23ft. above rail-level, and 46ft. long by 22ft. wide. A deck-house, for shelter in wet weather, 25ft. 3in. long and 12ft. 6in. wide, with a promenade deck, is provided. The car when fully loaded will weigh about 50 tons, and it would require a wind pressure nearly equal to three times that of a hurricane, or 134·4lb. per square foot of exposed surface, to create an equilibrium of forces—that is to say, if the inner line of rail is taken as the fulcrum and the weight of the car as acting vertically through its centre of gravity, we get $9 \times 60 \times 2{,}240$ units of resistance, taking the centre of pressure at 25·0 above rail, the area exposed 300 square feet, and x the lbs. per square foot, we get $x \times 25 \times 300 = 9 \times 50 \times 2{,}240 : x = 134{\cdot}4$. This force would only produce an equilibrium; the force therefore required to lift the car round the inner rail as a turning centre and turn it over would, of course, be very much larger. The margin of stability of the car from overturning from an impediment in the permanent way is very great.

The electrical generating station is at Rottingdean, and the current is conveyed to the car by an overhead copper wire and trolley pole. The motors are placed on the main deck of the car, and are connected with the driving wheels by shafting down two of the steel tube legs and bevel gearing. On the rear bogies powerful hand-brakes are fixed. The prime mover is one of Sissons's compound high-speed surface-condensing engines, indicating 110 h.p., driving a direct-coupled dynamo. The two motors have an effective brake horse-power of 30 each, and it is anticipated that they will drive the car at six miles per hour. The selection of a motive power for this line was comparatively easy; there were practically only two to choose between (1) steam and (2) electricity. Steam, of course, could have been adopted, but the heat from the boiler was looked upon as a disadvantage, therefore electricity was decided upon and adopted.

Mr. Volk and the author, who are jointly responsible for these works, trust they will have the pleasure of showing such portion of the work as is completed to the members of the association. Electricity has established its own distinctive position among tractive powers—viz., for short-distance frequent services, such as street railways, because, when there are a large number of cars on a system worked from a central station they become like the properly-balanced reciprocating parts of a machine. Take, for instance, a system worked with 20 motorcars, with stopping places every 1,000 yards, each car requiring x horse-power for the first 50 yards, some proportion of x for 850 yards, say, for simplicity, $\frac{x}{2}$, and 0 for the remaining 100 yards while stopping, and 0 while at rest. Then, assuming that the traffic could be so arranged that five cars were starting, five making the centre portion of the run, five stopping and five at rest, we get $(x \times 5) + \left(\frac{x}{2} \times 5\right) + (0 \times 5) + (0 \times 5) = 7\frac{1}{2}\,x$, instead of the 20 x which would be required if each car had its own engine. Or take it that five cars are starting, 10 running and five either stopping or at rest, even then we get 10 x instead of 20 x. Of course, in this reasoning no account is taken of the greater efficiency of the large prime mover in a central station or the loss in the conduction. Up to the present it has not been brought within the limits of practical competition with steam for long-distance heavy traffic, although considerable experiments have been made in that direction. The difficulty of selection, therefore, occurs when the traffic to be dealt with is either very light and seldom, or heavy and for considerable distances, and for these cases no general rules can be laid down: they have each to be treated on their own respective merits. Take as an illustration the very extreme case of a street railway installation for a small town, where the total length of the line would be two miles, and where a half-hour service would suffice for the traffic. Two cars start one from each end at the same time and arrive at their destination 20 minutes after starting: therefore, for 33 per cent. of the time the prime mover is running it is doing no work.

The cable tramway and electrical tramway have one very distinctive feature in common—namely, the central generating station—the difference being the form in which the power is transmitted from the prime mover to the car. The two points, therefore, to be considered are the prime cost of the road and efficiency of the transmitter. The cost of the installation of a cable road is very much greater than that for an electrical trolley line, as may readily be understood when a comparison is made between the cost of the pole and wire and the under-

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ground conduit furnished with cable and sheaves, even after allowing for the cost of the dynamos and motors. The efficiency is also less—that is to say, that with a given horse-power at the generating station, the effective horse-power available in the axle would, with the cable system, be just half that with an electrical system. Further, the electrical system is capable of far greater extension without additional generating stations than the cable system, as the length of a cable is limited, and that of an electric system (by the introduction of transformer stations) is, within reason, practically unlimited.

In conclusion, the author looks forward to the time when the road motorcar shall have been brought to perfection, whether it be driven by steam, oil, electricity, or by some power the discovery of which is still in the womb of the future. There is no doubt the advantages to civilisation will be large, but, to a great extent, an unknown quantity. Of one thing we may rest assured—viz., that the increased cleanliness of the streets in large towns will enormously add to the salubrity. What would the general public say if engineers suggested a tractive force which would deposit on the roads the same amount of noxious matter as results from horse traction. A further advantage will be the decrease in the amount of foodstuffs for which we shall be dependent on foreign countries, for instance. The horses in London would alone consume more than the produce of a million acres of ground. The saving of the space occupied by the horses, which equals at least 50 per cent. of the total area occupied by the traffic, would be sufficient to relieve many heavy congested districts, even in London.

After the reading of the paper an adjournment was made to the Brighton central electricity station in North-road, where the important extensions, which we illustrated last week, and which are approaching completion, were inspected by the members of the association. We understand the extension and the old buildings when full will contain about 12,000 h.p. of machinery, which it is expected will suffice for the electrical requirements of Brighton for a few years. The designs have been made by Mr. May, the borough engineer, and the machinery is under the control of Mr. Wright, the borough electrical engineer. The structural work is being carried out by Messrs. W. A. Field and Co., contractors, of Brighton. It surprised some of the members to find that Mr. Wright was going to drive all his subsidiary machinery by means of electric motors, but he pointed out that small engines were not economical, and that if he generated his steam by means of a 2,000-h.p. plant, with a double transformation he could get his work done more economically even with that double transformation than if he drove the subsidiary machinery direct by means of small engines.

PRECAUTIONS NECESSARY IN THE USE OF ELECTRICITY IN COAL-MINES.*

BY H. W. RAVENSHAW.

It is proposed in this paper to offer a few suggestions, the carrying out of which may serve to minimise the risk both from shock and fire.

Shocks.—A very unpleasant shock can be obtained from a 600-volt circuit, even on dry ground, and the results might be very serious to anyone who was standing on a wet floor or in water. A shock may also cause a man to fall without directly injuring him, and for this reason gear-wheels and other moving parts should be well guarded in the neighbourhood of any switches, resistances, or motors, which might have to be handled during the running of the machinery. All parts of the electric circuit should be covered, so that it is not possible to touch them without deliberately taking off the protecting covers, and the metal cases of switches and junction-boxes should always be connected permanently to earth by a stout wire, either through the tramroad rails or to water-pipes in the vicinity. Motor bedplates should also be well earthed, especially if the machines be fixed on timber foundations. An instance has come before the author where a shock was obtained from a hauling rope, the hauling engine having been fixed to heavy timbers in a very dry pit, and an accidental contact having occurred between the motor and the frame of the hauling engine. Where parts, such as brushes, have to be handled while the circuit is alive, a sound dry timber floor, with perhaps a rubber mat and a wooden handrail for the man to steady himself by, are the best protection. Indiarubber gloves are most uncomfortable and clumsy; they are liable to be pierced by small chips of metal, in which case they are worse than useless, and, except in awkward situations, they are not to be recommended. Even with a low voltage it is possible to obtain a very severe shock, owing to the high pressure which is momentarily obtained in breaking the circuit of an electromagnet. The author cannot give any instance where loss of life has been traced to this form of shock, but the experience of anyone who has accidentally broken the circuit of even a small magnet, and whose body has remained as a shunt to the break, is one to be remembered for a lifetime. Great care should therefore be taken in handling the wires connected to the field magnets.

Main Conductors – One of the principal characteristics of electric power is the enormous amount of heat which can be concentrated into a small space, and consequently the high temperature which results. These conditions can be obtained either by an arc being formed, as in the case of a broken wire, when a considerable amount of energy is expended in the air gap; or by a short-circuit, where practically the whole of the power which can be generated is concentrated in a comparatively small part of the system. The result of a short-circuit, extending as it does to the generating station, is easy to deal with, and fuses or other automatic devices can be employed to break the circuit before much damage is done. In certain cases, however, a partial short-circuit may cause great heating, although the current due to the reduced resistance may not be sufficient to blow the fuses at the generating station. It is imperative that the very best materials and workmanship be put into the cables. The difference in cost between the very best and the cheapest is so small that it is never advisable to even consider the desirability of using a cheap cable. Where the shaft is wet, the cable should be run in cast or wrought iron pipes having joints and junction-boxes made thoroughly water-tight. These protecting pipes should be carried as far into the mine as is necessary to get clear of the water. Where, however, there is no water, armoured cables may be used, care, however, being taken that they cannot be readily damaged by any accident to the cage. The usual method of carrying the cables from the bottom of the shaft to the motor is to suspend them from the timbers by means of insulators. In fixing them in this way there is great danger of the cables being damaged either by falls of the roof, breaking of the timbers, or by run-away wagons. In most cases, however, the cost of protecting the cables would be so great that this simple method is to be preferred, especially as they are accessible for inspection and repair. Several schemes have been suggested and some have been tried for preventing the occurrence of a spark or flame on the breakage of a cable. None of these arrangements has been generally adopted, and it is very doubtful whether any device can be relied on whose action must necessarily depend on the accurate adjustment of comparatively delicate apparatus. Personally, the author is very much in favour of the use of concentric cables, the external conductor being connected to earth at frequent intervals if not continuously. There are some draw-backs to this arrangement, especially in the switches and motors, but these can be guarded against, and the risk from fire in case of damage to the cables is enormously reduced. In the concentric cable, one conductor is thoroughly well insulated, and the other is stranded over the outside of this insulation. In some cases the outer conductor is used for the protection of the cable, no other insulation being used on the outside. It is, however, advisable to make the cable perfectly water-tight by means of leaden covering, and again to protect it with iron armouring. In damp places it may be necessary to cover the armouring with insulating material to prevent corrosion from electrolysis. A number of installations have been fitted up on this system, the outer or return wire being uninsulated or connected to earth. This, of course, has the disadvantage that the chance of breakdown from defective insulation is doubled; in fact, on the cable being damaged a short-circuit will be almost certain to occur on the particular section affected. This drawback is, however, really counter-balanced by the fact that defects at once show themselves, as the safety fuse breaks the connection in a part of the mine where the resulting spark can do no harm. It does not appear possible for the concentric cable to be broken without the inner wire coming in contact with the outer, causing a short-circuit, and cutting off the current at the fuses before the wires are severed, and preventing a big flash at a place where a fall of roof may have liberated gas.

Junction-Boxes.—Branches and joints should always be made in cast-iron junction-boxes in order that soldering may be avoided. These boxes should contain good solid terminals mounted on slate or porcelain, the opposite poles being well separated from each other. The cables should be taken through stuffing-boxes, and the wire so fixed to the terminals that it is impossible for the cables to be drawn out accidentally. The boxes must, of course, be watertight, the covers having faced joints so that loose packing is not required, as this always gets displaced in time.

Switches.—Where a branch occurs, a switch should be fixed in order that the circuit can be broken for testing or in case of accident. With concentric wiring a single-pole switch is only required, which will break the circuit of the inner wire. In

* Abstract of paper read before the Federated Institution of Mining Engineers.

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double wiring, however, both poles should be provided with switches. Switches must always be so made that there is no fear of an arc being started on breaking the circuit, and it is most important that with double-pole switches the parts of opposite potential operate in quite separate compartments, having a division of slate or porcelain between them. The break should be at least 6in. long on each pole. Switch-boxes should be lined with slate to prevent an arc being started on to the metal case. It should be absolutely certain that, when the switch is turned off, the circuit is entirely broken. It is difficult to conceive a more unpleasant predicament than for a switch to take charge and start an arc on its own account instead of breaking the circuit. This has actually occurred in practice where the switches have been designed so as to be neat and compact and efficiency of working has been overlooked. It is quite easy to make a switch which will always perform its functions without risk of failure, and no expense should be spared in this part of the plant. Where switches are enclosed in metal cases, they must be perfectly airtight. Stuffing-boxes for the cables are always liable to leak, and it is advisable where there is gas to have a separate box carrying the terminals, into which the cables can be brought, the connections to the inside of the switch being sealed up with bitumen or similar material. Resistance frames in connection with starting and regulating switches are always liable to cause contact with the earth. When porcelain insulators are used, the frame to which they are fixed should also be insulated, so that in case of a broken insulator the wire which it has supported will not make contact to earth. Wire coils are often used for resistances, and are usually flexible and liable to knock against each other or against their supports. They should be so spaced that it is impossible for them to touch surrounding objects, as a more or less dangerous spark might be caused by adjacent coils coming in contact. All resistances should be amply large enough to carry all the current that it is possible to put through them without over-heating. In some cases, as on coal-cutters, it would be impossible to fit resistances which would be capable of carrying the current continuously. In this case the switch must never be left in an intermediate position—in fact, it should be made so that it is impossible to leave it in any position except wholly on or wholly off. Water resistances in which the circuit is broken between the surface of water or a weak alkaline solution, and a metal or carbon contact, are very suitable for starting motors gently, as they can be made so that there is no spark between the contact and the surface of the water. As, however, the water is decomposed, these switches should not be enclosed in such a way that the explosive gases generated can accumulate. This form of switch is very simple, and is not liable to get out of order.

Motors.—Although the electric motor is now fairly well standardised, it is very important that the type of machine chosen is suitable for the work it will have to do. Where a large number of motors are in use on the same installation, it is usual to put down either shunt-wound or compound-wound machines which work in parallel. Very fair regulation can thus be obtained, and if the cables be properly proportioned the starting or stopping of any one motor should not affect the speed of any other. Where, however, only one motor is used it is advisable to have both motor and dynamo series wound. If these machines be properly designed, the speed regulation of the motor, given a regular speed of the dynamo, will be good, and this combination has the great advantage that when the motor is switched off the dynamo gives no volts and takes little or no power. Series motors have in many cases been used in parallel with other machines for driving pumps. These work well so long as the load is constant, but the motor tends to race if the pump loses its water, and it is advisable for this reason to use a compound-wound motor designed so that it will start readily under load, and will not run away when the load is taken off.

Motor Magnets.—With a series motor the field magnets are very simple, having a comparatively small number of turns of thick wire, which are not liable to be broken or to get displaced. Many of the most successful plants both at home and abroad are arranged on this plan, and it is at times advisable, when there are several motors, to provide an independent dynamo for each. This arrangement has also the advantage that the motor starts very steadily and without shock. Shunt-wound and compound-wound motors are formed with thousands of turns of fine wire, and when the coils are connected across a circuit having a pressure of, say, 600 volts, the wires on adjacent layers have a considerable difference of potential between them. This is a source of breakdown, as if the insulation be defective a partial short-circuit will occur which may in time burn through the fine wire. In fact, cases have occurred where an arc has been started in a shunt coil and the wire very badly burnt, if not destroyed. For this reason the wire must be thoroughly well insulated, and adjacent layers separated by an effective insulating material. The breakdown of the insulation between the wire and the frame of the machine is another source of trouble. The author has seen otherwise well-made machines with only a sheet of Willesden paper between the metal former carrying the coil and the wire itself. There should always be at least ¼in. space between the wire and the metal parts of the machine, mahogany or teak being used to separate the winding from the metal former. When the circuit of an electromagnet is broken, a very high pressure is momentarily produced, which will find out any weak places in the insulation, besides causing a bad spark where the circuit is disconnected. With high-tension shunt magnets, the pressure at breaking is enormous. This danger can be avoided, however, by using a switch which will insert a resistance in parallel with the magnet to be broken just before breaking, the resistance being left in parallel so that the magnet coil can discharge itself at its leisure. If the resistance be properly proportioned and wound non-inductively—that is, so that it does not tend to resist a sudden flow of current—the spark at breaking the circuit of a magnet weighing many tons can be reduced to very small dimensions. In certain cases the switches can be so arranged that the magnets are permanently left in parallel with the armature. It is, however, always advisable, with large motors, to use a switch and resistance as above described, as it is usual to excite the magnets of the motor a minute or two before the armature current is turned on. Series magnet coils will also cause sparking at the switch when the motor is cut off, consequently both motor and dynamo should be fitted with a resistance permanently connected in parallel with the series magnet coil. This resistance absorbs very little power and reduces the spark on breaking the circuit to a very small amount. By taking the above-mentioned precautions, the sparking at the switches can be reduced to a mere speck and the danger from breakdown is practically eliminated.

Motor Armatures.—The most important, and unfortunately the most complicated, part of a continuous-current motor is the armature, but although few radical alterations have been made in the last 10 years many details have been improved, and, given good workmanship, an armature should run without repairs for several years. The use of geared wheels has been one of the most fruitful causes of expense, the rapid vibrations transmitted to the armature being certain to eventually destroy the armature. In certain cases where the speed of the armature is below 500 revolutions per minute, and where the construction is particularly good, an armature will run for many months without repairs, but wherever it is feasible belt driving or worm gearing should be used for the first reduction of speed. It is a remarkable fact that in many cases under heavy vibration an armature gives way mechanically while the insulation remains intact. Consequently, the armature and commutator should be fixed to the shaft by the most efficient mechanical means possible. Two forms of armature are commonly used, having respectively the Gramme or the drum winding. In the former the wires pass through the centre of the armature, the iron core being a hollow cylinder supported on gunmetal arms. This type of armature has been in very general use in collieries, it being considered more suitable for high voltage than drum winding. The drum armature has been used a great deal lately and has many advantages which generally outweigh those of the Gramme. The construction of this armature necessitates the winding of wires, having the full voltage between them, side by side, along the periphery, and unless these are well insulated a short-circuit may occur between them. In the Gramme winding, however, there is a much lower voltage between wire and wire, and in small armatures it is possible to repair a burnt-out coil in a comparatively short time. When, however, large armatures are Gramme-wound, the space inside the core for the wire has to be made as small as possible to keep the size of the machine within reasonable limits, and wires having considerable difference of potential between them are packed together inside the armature. In fact, in case of a burnt-out coil, it is almost always necessary to rewind a sixth or a quarter of the armature. In the ordinary wire-wound drum armature there is an accumulation of wires at the end where the various sections cross one another, but during construction it is very easy to insulate these so that there need be no fear of short-circuit. Drum armatures are, however, being made in which the wires are brought round the end of the armature symmetrically, avoiding contact between wires of opposite potential. Apart from a somewhat greater liability to short-circuit, and in some cases less facility for repair, the drum armature has many advantages over the Gramme, some of which are enumerated below. The armature can be made smaller and lighter for the same work. There is much less liability to spark at the commutator. The armature is a good deal cooler, especially in the larger sizes (this is most important where enclosed machines are used), and mechanically the armature can be made stronger, the charcoal-iron plates being keyed direct on to the shaft without the intervention of a gunmetal spider. In the estimation of the author, however, the greatest advantage lies in the fact that on the occurrence of a short-circuit a drum armature stops at once and refuses to turn round. This causes a great rush of current, which blows the fuses and disconnects the circuit at once. As the current is cut off automatically a drum armature is seldom badly burnt, as the time during which the current is flowing through the short-circuit is too short for

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much damage to be done. With a Gramme winding, however, the armature may continue to revolve for a long time after a short-circuit has occurred, in which case the armature will be badly burnt, and dangerous sparks or flames given off.

Enclosed Motors.—In fiery mines it is usual to enclose the armature or the commutator in gastight covers, so that an accumulation of gas may not be fired by the sparking at the commutator. It has been contended that it is impossible to fire gas from these sparks, but although a good dynamo will run perfectly at the brushes there is always a chance of sparking owing to the brushes chattering, or to a damaged section of the commutator. The author has designed a large number of enclosed motors during the last few years, and, in his opinion, so long as the covers are really well made and the joints are kept perfectly gastight, they will afford ample protection. There is, however, great danger of the covers being taken off or the joints being improperly made, and it is a question whether they are to be relied on. In large motors there is some difficulty in getting sufficient surface to dissipate the heat which is transmitted from the armature to the covers, and water or compressed-air circulation has been used with good results. Where compressed air is available a constant pressure may be kept up inside the covers, which will effectually exclude any gas which may be about. In any case, it is advisable to thoroughly ventilate the chamber in which the motor is placed, and if this be done, it is doubtful whether it is necessary to enclose the armature. The greatest safeguard against accident is, however, good supervision and careful daily testing.

Testing.—It is most important that the insulation of the cables and the motor be tested daily before starting. This can easily be done from the generating engine-room by the use of testing sets which are at present in the market, and is of the utmost importance for the safety and efficiency of the plant.

ALTERNATE-CURRENT MOTOR TESTS.

The following is the report of Prof. Silvanus P. Thompson, F.R.S., on the alternate-current motors of Mr. Walter Langdon Davies to the Alternate-Current Electric Motor Syndicate, Limited:

Gentlemen,—In accordance with your request to test the alternate-current motors of Mr. Langdon Davies and to report upon the same, I beg to hand you the following statement and result of tests:

Motors of two sizes have been submitted to me. They were designed to run upon an ordinary alternate-current supply at 100 volts, the frequency for which they were designed being 83 periods per second. They have been run both in my laboratory at Finsbury and on the supply circuit of the House-to-House Electric Lighting Company. One of them has also been used by me on the circuit of the London Electric Supply Corporation at a lecture at the Royal Institution.

These motors are constructed in accordance with the specification of patent No. 19,364 of 1894, and embody also some of the further improvements covered by specification No. 18,870 of 1895, both of these being the patents of Mr. Walter Langdon Davies.

The principle of these motors may be briefly stated as being that of using a simple alternating current to produce a rotatory magnetic field by a special method which enables the inventor to attain the advantages hitherto only fully realised by the two-phase and three-phase systems of currents. It has long been known that those advantages could be in degree realised by the device known as "splitting the phase" of the current; but this device has never hitherto been used to the best advantage. The two most important features of the new invention are that by proper proportioning of the coils and disposing them in appropriate angular positions on the principles worked out by Mr. Langdon Davies, the phase of the currents can be split and then recombined so as to yield a true revolving magnetic field without having recourse to condensers or liquid resistances. As a result the motors are of higher efficiency and start on load more readily than any other alternate-current motors of equal output.

The motors consist of two essential parts: The outer stationary part, consisting of a substantial ring core, which receives in perforations the windings of the circuits and is held in an outer metal case, which also supports the bearings. The inner revolving part is even more substantial, and consists of a copper structure resembling a small massive squirrel cage embedded in iron core discs, keyed upon a steel shaft. This revolving part has no wires wound upon it, no commutator, no brushes, or other electric connections which might cause a spark, being entirely self-contained and receiving its electric currents purely by induction. In this respect these motors agree with the well-known induction motors used for two-phase and three-phase currents and with some of the earlier single-phase induction motors. The chief improvements are in the stationary part, since it is in this part that the inductive actions are determined which drive the revolving part, and on which the efficiency of the motor mainly depends.

The larger size of motor, denominated the E type, is of ¾ h.p., though the tests show that it will give out nearly 9-10 h.p. It is a tetrapolar machine, weighing 125lb., 8in. long, and 12·5in. high. The inner revolving part is 4⅞in. in diameter, and run at from 2,550 to 2,250 revolutions per minute, according to load. As will be seen from the accompanying tests, the apparent drop in speed from no load to full load was under 12 per cent.; the real drop was less, as the frequency of the supply had fallen toward the end of the tests.

At the time of these tests the frequency of the supply was found to be 85·6 periods per second and the voltage 99·75; but both the frequency and voltage were found to vary slightly from time to time owing to the varying nature of the demands of houses in the neighbourhood on the supply in the public mains.

The power given out by the motor was measured by a Raffard brake adapted to absorb several horse-power. The friction at the bearings of this brake was found to be rather unduly large owing to worn state of the bushes, and a preliminary trial showed that no less than 148 watts, or about 1-5 h.p., was absorbed thereby when the motor was running idle at a speed of 2,365 revolutions per minute. The power measurements made on the brake had therefore to be increased by crediting to them a corresponding allowance in lieu of any more direct measurements of the total output of power.

The accompanying tables of data and curves show that the maximum power developed by this motor was 0·85 of a horse-

Sheet I.

Brake load (pounds).	Speed.	Brake power. Horse-power.	Brake power +correction. Horse-power.	Torque (pound-feet).	Volts.	Amperes.	Ampere reading.	Apparent power. Watts.	Wattmeter reading.	True power. Watts.	True power. E.H.P.	Power factor.	Efficiency. Per cent.	Remarks.
Brake unconnected...	2,552	—	—	—	99 5	8·4	6·5	819	4	161	·21	·19	—	Speed of field 2,568.
Friction of brake bearing and coupling only.....	2,369	—	—	—	100 3	9 2	8 0	924·5	6 75	271·7	·36	·29	—	∴ slip at zero load 1½ per cent.
	2 361	—	—	—	100 1	9 5	8 5	951·3	6·75	271·7	·36	·28	—	
2... ;	2,540	·246	·394	·508	99·75	9·5	8 5	948	10·0	402·5	·54	·42	73	—
	2,500	·241	·389	—	98 75	9·2	8·0	910	9·5	382·4	·51	·42	76 3	—
3......	2,450	·355	·503	·762	100 0	10·3	10 0	1030	10·0	402·5	·54	·39	93·1	—
	2,330	·338	·486	—	100·5	9·8	9 0	982 6	9 5	382·4	·512	·38	91·5	—
	2 330	·338	·486	—	100·0	10·3	10 0	1030	9·5	382·4	·512	·37	91·5	—
4...........	2,670	·439	·587	1·016	99·75	11·5	12 5	1149	12·5	503·1	674	·44	94·2	Speed of field 2,409, slip at ⅔ load, ∴ about 5½ per cent.
	2,280	·441	·589	—	99·0	11·75	13 0	1163	12·5	503·1	·674	·43	94 3	
5	2,310	·558	·706	1 270	99·5	11·9	13·5	1191	13·5	543 4	·728	·45	96·9	Considerable vibration of brake.
	2,315	·559	·707	—	99·0	12·2	14·0	1207	14·0	563 5	·755	·46	93·6	
6......	2,287	663	·811	1·524	99 5	14·2	19 0	1414	15 5	623 8	·836	·44	95 9	—
	2,280	662	·810	—	99·25	14·2	19 0	1410	15 5	623·8	·836	·44	95 9	—
6 5.........	2,258	·709	·857	1·651	99·5	15·6	23·0	1555	17	684·2	·917	·44	93·4	—
	2,240	·704	·852	—	99·25	15·8	23·5	1568	17	684 2	·917	·43	92 9	—
	2,258	·709	·857	—	99·5	15 5	22·5	1538	18	724·5	·971	·47	88·2	—
	2,252	·707	·855	—	99 75	15·3	22·0	1525	17·5	704·4	·944	·46	90·5	—
7...............	—	—	—	—	—	—	—	—	—	—	—	—	—	Motor pulled up.

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power, the efficiency at this output being about 91 per cent. At half-load the efficiency was about the same, but rose in between to about 95 per cent. or higher. At one-third load the efficiency was about 75 per cent.

The high efficiency shown by these tests was confirmed by the general absence of noise and smoothness of running, and by the cool state of the machine at end of the tests. There was no undue heating in any part, and the rotating part was quite cool.

To test the capability of the motor for starting on a dead load various weights were hung upon a cord of a thickness slightly exceeding $\frac{1}{4}$in., which was wound around a pulley $2\frac{5}{8}$in. in diameter, and the motor was started against the load so hung upon the pulley. The greatest weight which could thus be applied was $3\frac{1}{4}$lb. In certain position weights exceeding this could be used. Had the test been less direct, involving use of belting or any gear admitting of backlash or slip, the motor would have started against dead loads considerably greater. This load of $3\frac{1}{4}$lb. on a $2\frac{5}{8}$in. pulley represents an initial torque of about four-tenths of one pound-foot. This is about one-half the torque at the maximum output.

The starting of the motor is accomplished in the simplest manner by the turning of a switch provided with two contact points, the first contact being the position for starting, the second contact being the position for running when the motor has got up its proper speed.

The smaller motor, denoted the C type, is a two-pole motor, which runs at about 4,500 revolutions per minute, and yields about 1·6 h.p. It also runs quite cool, and starts on an initial load. Sheet I., annexed hereto, gives the numerical data of the tests of the larger motor.

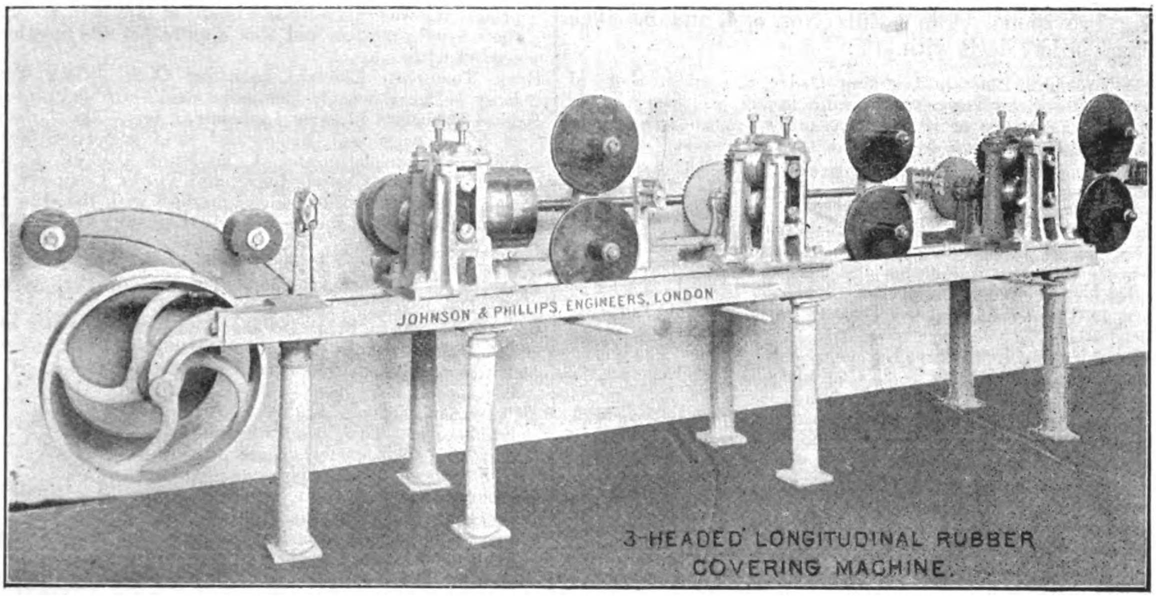
To sum up: these alternate-current motors possess a remarkably high efficiency, and are self-starting to a degree hitherto unattained.

There ought to be a very large demand for motors of this class, since alternate currents are used in half of all the stations recently erected for the public supply of electricity.

May 9, 1896. (Signed) SILVANUS P. THOMPSON.

LONGITUDINAL COVERING MACHINE.

We publish in this issue an illustration of the three-headed longitudinal covering machine manufactured by Messrs. Johnson and Phillips, who are practically the pioneers in this class of

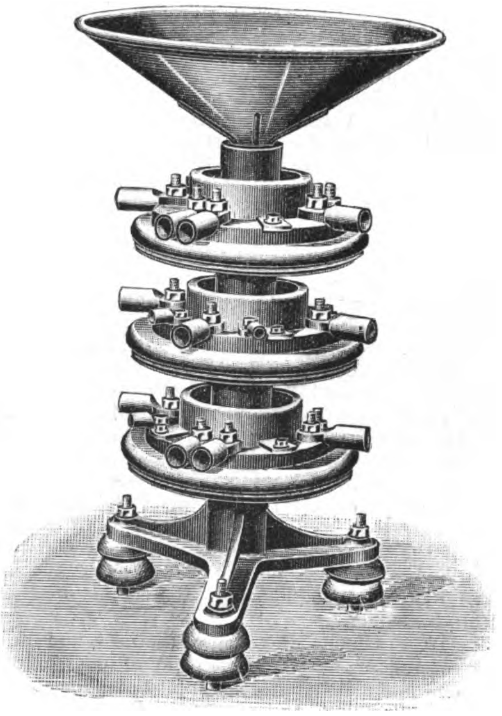


3-HEADED LONGITUDINAL RUBBER COVERING MACHINE.

machinery. This machine is arranged for putting three coats of rubber on simultaneously—viz., one of pure, two of compounded, or three layers of compounded. The many repeat orders the makers have received for it is the best proof of its appreciation in manufacturing circles. For quantity and quality of work produced it is unequalled, being arranged to cover any number of wires up to 12 simultaneously. It is capable of turning out about 30 miles of covered per day without any fault, which is very exceptional with this type of machine. It entirely displaces the old type of machine in which the rubber is squeezed round the wire through dies. We are informed that the insulation obtained by this machine is absolutely perfect, whereas with the other type only very inferior rubber compound could be used, and consequently only very low insulation could be obtained.

THE WORDINGHAM PILLAR DISTRIBUTOR.

Most engineers are agreed that it is desirable to interconnect a distributing network at as many points as possible, in order chiefly to equalise the pressure. If this interconnection is well carried out, it further enables smaller feeders to deal with the constantly shifting area of maximum demand. The great drawback



to such interconnection is the difficulty of localising a fault should one occur, and with a view to providing for this it is essential that all linking points should be capable of rapid disconnection. This is by no means easy to provide for in a neat and convenient manner when there are many cables meeting in one point, say where four streets meet, and the difficulty is very largely increased when the distribution is effected on the five-wire system, since the number of cables is largely augmented. The necessity for some convenient apparatus of high insulation for the purpose named led Mr. C. H. Wordingham, chief engineer to the Manchester Corporation electric works, to devise the apparatus illustrated in this issue, to which he has given the name of "Pillar Distributor."

A central, hollow, cast-iron column standing on three oil insulators is fixed in the junction-box. From this column project at five different levels three cast-iron lugs 120deg. apart, cast in one with the column. Five cast-iron plates, each having three slots separated from one another by 120deg., and three recesses on the underside placed between the slots, are provided. One of these plates is slipped over the pillar, the slots allowing it to pass the lugs until the bottom three lugs are

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reached. The plate is then turned through an angle till the recesses are opposite the lugs. The plate is then dropped down, and takes a firm seat. On the plate are placed two flat rubber rings, which serve as a bed for a porcelain insulator of the form shown. This insulator is large enough to slip past the cast-iron lugs. Three slate wedges covered with indiarubber strip are placed between the insulator and the pillar, so that the insulator is firmly fixed. A substantial ring of gunmetal is now placed on the insulator; this ring is prevented from slipping about by means of four small brass pieces secured by bolts, and rendered adjustable by means of slots. This ring has studs and tapped holes, which admit of a large number of lugs into which cables are sweated, being affixed to it by means of nuts and bolts. A second cast-iron plate is now slid down the pillar and fixed on the next three lugs from the bottom, and an insulator and ring placed on it as before described. Three more cast-iron plates which, with its insulator and ring, are then fixed on the remaining lugs. A large funnel is slipped on to the top of the pillar. This serves to collect any water that may drip into the junction-box, and so prevent it from falling on the apparatus. The water runs down the funnel through the interior of the column.

The illustration shows the apparatus complete without any cables attached. Such a pillar distributor is capable of dealing with a very large number of cables. Each ring can readily have 6½ square inch cables and six smaller ones attached to it—that is to say, the pillar as a whole will deal with 70 cables. A considerable number of these distributors have been introduced into the Manchester network with the most marked success; indeed, they are being placed at all important points of intersection. It is quite easy to disconnect the five cables which pass down a street in as many minutes, and in case of a fault portions of the network from which a large supply is being taken can be broken with perfect safety. On one occasion as much as 1,700 amperes at 200 volts was successfully disconnected on one of these pillars.

Messrs. W. T. Glover and Co., of Salford, and 39, Victoria-street, Westminster, have the sole right of manufacturing these Wordingham pillar distributors, samples of which may be seen at their works or offices, and also at the Cardiff Exhibition.

ELECTRIC LIGHTING PROVISIONAL ORDERS.

The following gives the House of Commons returns of the memoranda stating the nature of the proposals contained in the provisional orders included in the Electric Lighting Provisional Orders Bills Nos. 3, 4, and 5. The provisional orders dealt with are:

The Bray Township Electric Lighting Order, the undertakers of which are the Bray Township Commissioners, and the area of supply the Township of Bray. The order contains the usual provisions, and mains are to be laid within two years.

Cork Electric Lighting Order, 1896.—The undertakers are the Corporation of Cork, and the area of supply is the City or Borough of Cork.

Liverpool Electric Lighting Order, 1896.—The undertakers are the Corporation of Liverpool. The area of supply is the City of Liverpool, and the order, besides the usual provisions, also provides for the revocation of the Liverpool Electric Lighting Orders, 1891 and 1892, and the Toxteth Park Electric Lighting Order, 1891.

Queenstown Township Electric Lighting Order, 1896.—The undertakers are the Queenstown Town Commissioners, and the area of supply is the Township of Queenstown.

Rathmines and Rathgar Township Electric Lighting Order, 1896. The undertakers are the Rathmines and Rathgar Improvement Commissioners, and the area of supply is the Township of Rathmines and Rathgar.

Sale Electric Lighting Order, 1896.—The undertakers are the Urban District Council of Sale, and the area of supply is the Urban District of Sale. The provisions in these orders are similar to those in the case of Bray.

Great Berkhamsted and Northchurch Electric Lighting Order, 1896.—The undertakers are the Bedford Electric Light Company, Limited, and the area of supply is a portion of the Parishes of Great Berkhamsted and Northchurch.

Great Crosby and Waterloo Electric Lighting Order, 1896.—The undertakers are the Liverpool District Lighting Company, Limited, and the area of supply is the Urban District of Great Crosby and the Urban District of Waterloo-with-Seaforth.

Margate Corporation Electric Lighting Order, 1896.—The undertakers are the Corporation of Margate, and the area of supply is the Borough of Margate.

Pembroke Township Electric Lighting Order, 1896.—The undertakers are the Pembroke Township Commissioners, and the area of supply is the Pembroke Township. The provisions of all these orders are on the same lines as above.

St. Saviour's District Electric Lighting Order, 1896.—The undertakers are the County of London and Brush Provincial Electric Lighting Company, Limited, and the area of supply is a portion of the District of the St. Saviour's District Board of Works. The provisions are similar to Camberwell.

Battersea Electric Lighting Order, 1896.—The undertakers are the Vestry of the Parish of St. Mary, Battersea, and the area of supply is the Parish of St. Mary, Battersea. This order contains provisions for prohibiting the supply of energy by the undertakers beyond the area of supply, otherwise than under the authority of Parliament, or under a license granted by the Board of Trade; for prohibiting the use of overhead wires without the consent of the Board of Trade and the London County Council; and for enabling the County Council to require the undertakers to place their mains, etc., in subways, where such subways exist.

Camberwell Electric Lighting Order, 1896.—The undertakers are the County of London and Brush Provincial Electric Lighting Company, Limited. The area of supply is a portion of the Parish of St Giles, Camberwell, and besides similar provisions to the Battersea order the order contains provisions for securing that the undertakers shall not purchase or acquire the undertaking of, or associate themselves with, any other company or person supplying energy under any license, provisional order, or special Act within the Administrative County of London, unless the undertakers are authorised by Parliament to do so, and for authorising the local authority to purchase the undertaking at any time after the commencement of the order, on certain terms specified in the order.

The following are the applications for provisional orders received by the Board of Trade since the date of the last report, together with the names of the promoters and how dealt with by the Board of Trade:

Allerton, Woolton, Childwall and Garston Electric Lighting Order.—The Urban Districts of Allerton, Little Woolton Much Woolton, Childwall, and Garston.—Liverpool District Lighting Company, Limited.—The promoters failed originally to produce the consents of certain of the local authorities, and the Board of Trade directed that a local enquiry should be held. The consents of the local authorities were subsequently produced, and the Board of Trade granted the order.

Ambleside Electric Lighting Order.—The Urban District of Ambleside.—Windermere and District Electricity Supply Company, Limited.—The promoters failed to produce the consent of the local authority, or to satisfy the Board of Trade that it should be dispensed with, and the Board of Trade refused to grant the order.

Ashton-on-Mersey Electric Lighting Order.—The Urban District of Ashton-on-Mersey and a portion of the District of the Bucklow Rural District Council.—Altrincham Electric Supply, Limited.—Order granted.

Bath Electric Lighting Order.—The City of Bath.—The Corporation.—Order granted.

Bath Electric Lighting Order.—The City of Bath.—City of Bath Electric Lighting and Engineering Company, Limited.—An application was also received from the local authority, to which preference was given by the Board of Trade in accordance with their usual practice, and this application was not therefore proceeded with.

Bray Township Electric Lighting Order.—The Township of Bray.—The Township Commissioners.—Order granted.

Bristol Suburban Electric Lighting Order.—The Urban Districts of St. George and Kingswood and a portion of the Urban District of Stapleton and of the Rural District of Warmley.—Great Western Electric Light and Power Company, Limited.—The promoters decided not to proceed with the application

Colwyn Bay and Colwyn Electric Lighting Order.—The Urban District of Colwyn Bay and Colwyn.—The Urban District Council.—Order granted.

Cork Electric Lighting Order.—The City or Borough of Cork.—The Corporation.—Order granted.

Cowes Electric Lighting Order.—The Urban District of Cowes.—The Urban District Council.—Order granted.

Devonport Corporation Electric Lighting Order.—The County Borough of Devonport.—The Corporation.—Order granted.

Folkestone Electric Lighting Order.—The Urban District Folkestone.—The Corporation.—Order granted.

Gloucester Corporation Electric Supply Order.—The City o Gloucester.—The Corporation.—Order granted.

Godalming Electric Lighting Order.—The Municipal Borough of Godalming.—The Corporation.—Order granted.

Great Berkhamsted and Northchurch Electric Lighting Order.—Portions of the Parishes of Great Berkhamsted and Northchurch.—Bedford Electric Lighting Company, Limited.—Order granted.

Great Crosby and Waterloo Electric Lighting Order.—The Urban Districts of Great Crosby and Waterloo-with-Seaforth.—Liverpool District Lighting Company, Limited.—Order granted.

Huddersfield Electric Lighting Order.—The County and Municipal Borough of Huddersfield.—The Corporation.—Order granted.

Ipswich Electric Lighting Order.—The Borough of Ipswich.—County of London and Brush Provincial Electric Lighting Company, Limited.—The promoters failed to produce the consent of the local authority, or to satisfy the Board of Trade that it should be dispensed with, and the Board of Trade refused to grant the order.

Keswick Electric Lighting Order.—The Township of Keswick and portions of the Townships of St. John's, Castlerigg, and Wythburn, Underskiddaw, and Above Derwent.—Keswick Electric Light Company, Limited.—An application was also received from the local authority, to which preference was given by the Board of Trade, in accordance with their usual practice, and this application was not therefore proceeded with.

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Keswick Electric Lighting Order.—The Urban District of Keswick. The Urban District Council.—Order granted.
Kettering Electric Lighting Order.—The Urban District of Kettering.—The Urban District Council.—Order granted.
King's Lynn Electric Lighting Order.—The Borough of King's Lynn.—The Corporation.—Order granted.
Kingstown Township Electric Lighting Order.—The Township of Kingstown.—The Township Commissioners.—Order granted.
Liverpool Electric Lighting Order.—The City of Liverpool.—The Corporation.—Order granted.
Manchester Electric Lighting Order.—A portion of the City of Manchester.—The Corporation.—Order granted.
Margate Corporation Electric Lighting Order.—The Borough of Margate.—The Corporation.—Order granted.
Merthyr Tydfil Electric Lighting Order.—A portion of the Urban District of Merthyr Tydfil.—J. C. Howell, Limited.—Order granted.
Middleton Electric Lighting Order.—The Borough of Middleton. The Corporation.—Order granted.
Newmarket Electric Lighting Order.—The Urban District of Newmarket and a portion of the Rural District of Newmarket.—Newmarket Electric Light Company, Limited.—The promoters failed to produce the consent of the Urban District Council or to satisfy the Board of Trade that it should be dispensed with, and the Board of Trade refused to grant the order.
Pembroke Township Electric Lighting Order.—The Township of Pembroke.—The Township Commissioners.—Order granted.
Prescot District Electric Lighting Order.—The Urban District of Huyton-with-Roby, and the Parishes of Rainhill, Whiston, and Eccleston.—British Insulated Wire Company, Limited.—The promoters failed to produce the consents of the local authorities, and the Board of Trade directed that a local enquiry should be held. After consideration of the report made by the inspector appointed to hold the enquiry, the Board of Trade were of opinion that no reasons had been advanced sufficient to justify them in dispensing with the consents of the local authorities, and they refused to grant the order.
Queenstown Township Electric Lighting Order.—The Township of Queenstown.—The Town Commissioners.—Order granted.
Rathmines and Rathgar Township Electric Lighting Order.—The Township of Rathmines and Rathgar.—The Improvement Commissioners.—Order granted.
Sale Urban District Council Electric Lighting Order.—The Urban District of Sale.—The Urban District Council.—Order granted.
Wells (City of) Corporation Electric Lighting Order.—The City of Wells.—The Corporation.—Order granted.

THE COUNTY OF LONDON.

Battersea Electric Lighting Order.—The Parish of St. Mary, Battersea.—The Vestry.—Order granted.
County of London (South) Electric Lighting Order.—The District of the St. Saviour's District Board of Works, and the Parishes of St. Mary, Newington; St. Mary, Lambeth; St. Giles, Camberwell; and St. Mary, Battersea.—County of London and Brush Provincial Electric Lighting Company, Limited.—Two orders granted: one in respect of a portion of the Parish of Camberwell; the other in respect of a portion of the District of St. Saviour's District Board of Works.
Newington Electric Lighting Order.—The Parish of St. Mary, Newington.—The Vestry.—Representations were received from ratepayers objecting to the application, and the Board of Trade directed that a local enquiry should be held. After consideration of the report made by the inspector appointed to hold the enquiry, the Board of Trade refused to proceed with the application.

LICENSES.

The following applications for licenses have been received since the date of the last report, and have been dealt with in the manner shown below:

The Corporation of Bangor.—The Municipal Borough of Bangor and portions of the Parishes of Pentir and Llandegai.—Representations were received from ratepayers objecting to the application and the Board of Trade directed that a local enquiry should be held. After consideration of the report made by the inspector appointed to hold the enquiry, the Board of Trade refused to proceed with the application.
Earl de la Warr and Robert Kersey.—A portion of the Parish of Bexhill.—Still under consideration.
The Corporation of Morley.—The Borough of Morley.—Still under consideration.
The Wallasey Urban District Council.—The Urban District of Wallasey.—Still under consideration.

Since the date of the last report the Board of Trade have approved a deed transferring to the Harrow Electric Light and Power Company, Limited, the powers, duties, and liabilities (with certain modifications and exceptions) under a provisional order granted to the Harrow Local Board in 1894; and the undertaking authorised by the Fareham Electric Lighting Order, 1892, has with the consent of the Board of Trade, been transferred by the Fareham Electric Light Company, Limited, to the Fareham Urban District Council.

New model regulations for securing the safety of the public and for ensuring a proper and sufficient supply of electrical energy have been made by the Board of Trade, and have been imposed upon all undertakers supplying energy.

Revised regulations for the purposes of Section 4 of the Electric Lighting Act, 1888, are now under consideration by the Board of Trade, and will shortly be issued.

OLDHAM ELECTRIC LIGHTING ACCOUNTS.

The following is the statement of accounts for the year ended March 25 last:

Expenditure on Capital Account.

	£	s.	d.
Supply station:			
Engines and dynamos	2,060	18	7
Batteries	329	17	7
Switchboard	346	13	9
Steam-pipes	155	16	11
Sundries	37	19	10
	2,931	6	8
Street mains	3,358	2	4
	£	s.	d.
Gross revenue for the year	3,847	14	3
Gross expenditure	1,577	17	9
Balance carried to net revenue account	2,269	15	7
Interest on loans, £813. 8s. 4d.: sinking fund, £608. 12s. 7d.	£1,422	0	11

The receipts for the present year and the balance brought forward from the previous year make the amount to be carried forward to the credit of the next year £1,749. 18s. 3d. The price of energy supplied to all consumers has been 6d. per unit. The minimum quarterly charge for energy was reduced from 10s. to 5s. from June last, and the charge for meter rent also reduced from that date. The greatest quantity supplied in 24 hours was on January 6, and was 1,242 units, against 651 last year. Applications for additional borrowing powers to meet the growing demand for the light have been acceded to by the Local Government Board to the extent of £15,000. The total length of the mains laid on March 25 was 5,763 yards.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Prestwich.—Tenders for putting into thorough repair the existing telephone system and electric bells at the county asylum, Prestwich, are invited. Full particulars on application at the asylum.

Bucharest.—Tenders will be received up to August 8 by the Roumanian Government (Department of Posts and Telegraphs) for the electric lighting of the new Posts and Telegraph building at Bucharest.

Spandau.—Tenders are wanted at the Royal Small-Arms Factory for 900 incandescent electric lamps by July 17. Particulars are obtainable for 75pfg. (9d.) from Die Königl. Direktion der Gewehrfabrik (Geschäftszimmer No. 21), Spandau.

Simla (India).—The Municipality is inviting tenders for lighting by electric light for a term of years the principal thoroughfares and buildings belonging to the Municipality. Tenders must be submitted by September 1 next. Should any proposal be accepted, the Municipality will afford the successful tenderer all facilities to extend the system of lighting to private houses.

Cologne.—Tenders are required by the Municipal Authorities for the construction and working of electric tramways in the city of Cologne to an aggregate length of 20·3 kilometres (12½ miles). Specifications, plans, and particulars are obtainable for 10 marks (10s.) from der Registrateur B, des Oberbürgermeisteramt, Köln, Germany, and tenders must be in by November 6.

Madras.—Tenders are invited for the lighting by electricity of Government House, Madras, including the banqueting-hall and aide-de-camps' bungalow, and also for the lighting of Government House, Guindy, including the military secretary's bungalow. For particulars application must be made to the consulting architect to the Government, Chepank, Madras. Tenders will be opened on November 11, 1896.

London, W.—Tenders are required for the supply of (1) coal to the electric lighting station, South Ealing; and (2) coal and coke to the other depôt of the Urban District Council. Printed forms of tender, conditions of contract, etc,, and any further particulars can be obtained on application to Mr. C. Jones, C.E., surveyor to the Council, between 10 and 4. Tenders, in envelopes provided, to be delivered by 4 p.m. on 16th inst.

Lisbon.—The Royal Portuguese Railway Company want tenders by July 22 for the supply of 10,000 porcelain insulators with galvanised iron supports, 200 sheets of asbestos (1 metre square by 2 millimetres thick), and about 2½ tons of galvanised iron wire. The tenders are to be addressed to the Chief of the Stores Department at Santa Apolonia Station, Lisbon and particulars can also be obtained at Paris, Rue de Châteaudun 28.

Voghera (Italy).—In view of the expiration of their contract with the local gas company in 1898, the municipal authorities of Voghera are desirous of receiving during the present year propositions for the lighting of the town either by the electric light or a mixed system of gas and electricity. The population is 16,000. Application should be made to L'Administrazione Comunale, Voghera, who will give all particulars necessary.

Battersea (London).—The St. Mary's Vestry will receive tenders up to July 14 for a complete installation of the electric light for the town hall and municipal buildings. Specifications and con-

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ditions can be obtained from Mr. R. Hammond, Ormond House, Great Trinity-lane, E.C., after a deposit of two guineas has been made with the Vestry Clerk, at the Vestry Offices, Lavender-hill, S.W. Clauses for the payment of trades union wages will be embodied in the contract.

Huddersfield.—Messrs. Learoyd Bros. and Co invite tenders for the wiring of the Trafalgar Mills. Copies of the specifications and general conditions can be obtained from Messrs. Shepherd and Watney, 71, Albion-street, Leeds, on payment of a cheque for £1. 1s, which will be returned on receipt of a bona fide tender. Tenders, endorsed "Electric Lighting," must be addressed and delivered to Messrs. Learoyd Bros and Co., Milnsbridge, Huddersfield, by 12 noon on July 7.

Mexico.—The municipal authorities of the city of Mexico are prepared to receive proposals for the street lighting by incandescent lamps for a period of eight years Tenders should be sent in by August 31. The Secretary of State for Foreign Affairs has received from the British Consul at Mexico a pamphlet issued by the Municipal Council of the city containing particulars as to the tenders, and this may be seen on application to the Commercial Department of the Foreign Office between the hours of 11 and 6.

San Juan (Puerto Rico).—H.M. Secretary of State for Foreign Affairs has received from H.M. ambassador at Madrid a copy of a Spanish Royal Order which has appeared in the *Gazette* inviting tenders for the construction and working of a telephone system in San Juan de Puerto Rico. A deposit of 800dol. must accompany each tender which will be considered on August 10. The copy of the Royal Order may be seen on application to the Commercial Department of the Foreign Office between the hours of 11 and 6.

Bedford.—Tenders are invited by the Urban Sanitary Authority for supply of steam coal to the electricity works, for one year ending July 23, 1897. The coal to be one of the following kinds: Annesley hard coal, Pilsley ditto, Linby ditto, or from some other approved colliery. Sealed tenders, endorsed "Tenders for Coal," to be sent to Mr. T. S. Porter, clerk, Town Hall, Bedford, by 14th inst, with samples of the coal proposed to be supplied. Every tender must be in a printed form, a copy of which may be obtained at the clerk's office. The person whose tender is accepted will be required to furnish the colliery certificate.

Ayr.—The Corporation invite tenders for the following stores for 12 months ending May 31, 1897, to be delivered at the Ayr burgh electricity works free of all charges: (1) best washed dross, 15 to 25 tons per week; (2) best long thread cotton waste per cwt.; (3) sponge cloths per gross; (4) engine-room stores; (5) picks, shovels, rammers, etc., for street work; (6) stationery; (7) general ironmongery; (8) plain smith's forgings, per lb.; (9) cleaning, painting vermilion and numbering in gilt the electric lamp-posts. All necessary information may be obtained from the burgh electrical engineer, Mill-street, Ayr, where patterns may be seen. Tenders, sealed and endorsed, to be lodged with Mr. A. G. Young, town clerk, Ayr, by 6th inst.

Wallasey.—For condensing apparatus and steam and exhaust pipes in connection with their electric light installation, tenders are invited by the Wallasey Urban District Council. Drawings may be seen, and copy of the specification obtained, on application to the engineer, Mr. J. H. Crowther, at the Gas and Water-works, Great Float, near Birkenhead, on payment of £2. 2s., to be returned on receipt of a bona fide tender. Sealed tenders, on the form provided, addressed to the chairman of the Gas and Water Committee, and endorsed "Tender for Condensing Apparatus, etc," to be delivered at the office of Mr. W. Danger, clerk to the Council, Public Offices, Egremont, Cheshire, by 4 p.m. on July 16 The contractor will be required to enter into a bond, with approved sureties, for the due performance of the contract.

Army Contracts.—The Secretary of State for War gives notice that tenders for specific quantities of the following articles will probably be invited from time to time during the next twelve months — namely: submarine mining electrical instruments, telegraph cable and wire, etc. Manufacturers who may wish to be applied to when tenders are required should address the Director of Army Contracts, War Office, Pall-mall, S.W., by letter, stating the particular articles which they manufacture, and the names of at least two well-known firms or public bodies who have purchased from them, and are in a position to certify as to the quality of their productions. Applications unaccompanied by references will not be noticed. Firms whose names are already on the War Office list need not apply, as forms for tendering will be sent to them in due course.

Kingston (Jamaica).—The Colonial Government invite electric tramway contractors willing to undertake the establishment and working of a system of rapid transit to send in applications for the grant of a license by the Governor in Privy Council under the Tramways Law, 1895. In all applications the principal questions to which attention should be directed are the following: (*a*) the amount of capital which the applicants are prepared to subscribe; (*b*) the system which it is proposed to establish; (*c*) the mileage of lines to be laid; (*d*) the fares to be charged; (*e*) the frequency of the service; (*f*) the length of the license required by applicants; (*g*) the guarantee which the applicants offer for the satisfactory performance on their part of any obligations devolving on them. Plans of the city of Kingston and part of the parish of St. Andrew, showing the routes on which the present tramway lines are laid, and copies of the law under which licenses are granted and of the rules made thereunder by the Governor in Privy Council, may be seen at the office of the Crown Agents for the Colonies, Downing-street, London, S.W. All applications must be delivered not later than July 31, 1896, in a sealed packet, marked on the outside "Application for Tramway License," to the clerk of the Privy Council, Kingston, Jamaica. Kingston has its principal means of transit at present supplied by the Jamaica Street Car Company by horse tramcars, the entire length of lines laid being about 12 miles. The concession granted by the Legislature of the island to the Jamaica Street Car Company will shortly expire.

RESULTS OF TENDERS.

Burnley.—The Gas and Electric Lighting Committee have accepted the tender of Messrs. Callender's Bitumen Telegraph and Waterproof Company, Limited, London, for the supply of electric cables for the Church-street extension at £600. 4s.

Brussels.—For converting local tramways for electric traction on June 17 the lowest of six tenders were those of the Compagnie générale de traction et d'électricité, of Paris, at 933,056fr. for lattice poles and 980 331fr. for tubular poles. The tenders of the Union Elektricitäts-Gesellschaft, Berlin, were 1,075,000fr. and 1,175,000fr. On a basis of so much per car mile the tenders of the Union were slightly the lower. No English firms tendered.

BUSINESS NOTES.

Jandus Arc Lamp.—We hear that, although the works have only been at full work for a few months, 700 of these lamps are in daily work.

Folkestone.—The Town Council have appointed Dr. Hopkinson, F.R.S., to investigate the agreement to be made with Mr. Hopkins for the sale of the order.

Devizes.—A firm has applied to the Corporation for a license to enable them to supply the electric light to business places in the immediate vicinity of their works.

City of London Electric Lighting Company, Limited.—The warrants for interest due on the 30th ult. on this Company's debenture stock have been posted.

Telegraph Messengers.—Lord Wolesley has held an inspection of telegraph messengers in Hyde Park. He expressed satisfaction at the way the drill, etc., was performed.

Newcastle.—An installation of electric light has been fitted in the new Presbyterian church at Heaton, the work being carried out by Messrs. Lummis, Paterson, and Co., of Heaton.

Auto-Electro Feed-Water Purifier Company, Limited.—This Company has been formed to acquire and turn to account a patent for the purification of the feed water of steam-boilers.

Address.—Mr. F. C. Allsop, manufacturing electrician, has dissolved partnership, and is now carrying on business entirely by himself, as in former times, at 97, Queen Victoria-street, E.C.

Dover.—The Corporation have resolved to support a petition to the borough member for the increase of the weight of motor vehicles in the Act now before Parliament of two to four tons.

The Telephone Trunk Line.—All the principal towns in the Midland and Eastern Counties are now in intercommunication, and the connections to the Northern Counties will follow shortly.

Western and Brazilian Telegraph Company.—For the week ending June 26 the receipts, after deducting 17 per cent. payable to the London Platino-Brazilian Telegraph Company, were £2,856.

Eltham (Kent).—The Guardians propose to connect the workhouse and the doctor's house by telephone The distance is 3½ miles, and the question will be settled at the meeting next week.

Whitehaven.—The Guardians wanted the road leading to the workhouse lighted by electricity, but it has since been ascertained that the road is not included in the limits of the borough under the electric lighting order.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending June 28 amounted to £1,219, as compared with £1,193 in the corresponding week of the previous year, being an increase of £26.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ending June 26 were £2,333. 19s. 4d., compared with £2,110. 13s. 3d for the corresponding period of last year, being an increase of £223. 6s. 1d.

British Electrical and Industries Company, Limited.—This Company has been started to acquire and carry on any businesses connected with the working of electricity in all its branches, and also to carry on the business of a supply stores.

Merthyr.—Messrs. J. C. Howell, Limited, have given notice to the Urban District Council of their intention to apply in the next session for a provisional order for lighting with electricity the whole of the area under the Council's jurisdiction.

Brighton.—At a meeting of the Recreation Grounds Committee of the Town Council an application was read from Mr. T. Duff Barnett, B.A., for permission to run two electric carriages in Preston Park for hire. The application was refused.

Electrical Manufacturers, Limited.—This Company has been formed to carry on the business of a dealer in electrical apparatus, electrician, and electrical engineer, carried on by H. E. Childs at 223, Upper Thames-street, E.C., and to adopt an agreement with the said vendor.

Cork.—A special assembly of the Council of the city will be held to-day to consider the application of the Cork Electric Tramway Company, and the amendments made on the draft Order in Council for construction of same, as recommended by the Public Works Committee of June 24.

Bath.—A Select Committee of the House of Commons, presided over by Colonel Gaunter, has passed a Bill confirming a pro-

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visional order of the Board of Trade authorising the Corporation to undertake the electric lighting of the city. There was no opposition to the confirmation of the order.

Consolidated Telephone Company, Limited.—The directors of this Company have resolved to recommend to the shareholders at the approaching annual general meeting that, subject to audit, a dividend at the rate of £1. 10s. per cent. per annum, less income tax, to be paid for the year ending March 31, 1896.

Fermoy.—A public meeting has been held to consider an offer made by Mr. F. J. Warden-Stevens, A.M.I.E.E., with regard to electric lighting. He stated that if a sufficient number of lights were guaranteed a private company would be formed for the purpose, the consent of the Commissioners having been obtained.

Southall-Norwood.—The postal authorities having applied for permission to erect posts and wires along the Church-path to Norwood Green Post Office, the Urban District Council decided that this permission be not given, but that permission be given to the wires being carried underground along the Church-path and Norwood-road.

City and South London Railway.—The returns for the week ended June 28 were £891, compared with £780 for the corresponding period of last year, being an increase of £111. The total receipts for the half-year terminating as above were £24,069, compared with £23 873 in the same period of the preceding year, being an increase of £196.

Portsmouth.—The Electric Light Committee of the Town Council have decided to send a deputation to towns in the Midlands to consult the engineers of electric light works where the types of engines which the committee contemplate purchasing are at work. This has been done in order to obtain the information for the guidance of the committee.

Aberdeen.—The interior of the Advocates' Hall Buildings is being fitted up with the electric light. The contract is in the hands of Messrs. Shirras, Laing, and Co., and is being carried out under the superintendence of their engineer, Mr. Botting. The other apartments of the suite and the spacious passages are also to be lighted by electricity. The current will be supplied from the Corporation mains.

Greenwich.—At the District Board meeting a letter was read from the secretary of the Blackheath and Greenwich District Electric Light Company, Limited, forwarding formal notice of application by that company for a provisional order under the Electric Lighting Acts, 1882-1888, authorising that company to supply electricity for public or private purposes within the area of this Board. It was referred to the Greenwich Committee.

East Grinstead (Sussex).—A notice was received at the Urban District Council meeting from the electric lighting company stating that they intended to apply forthwith, under the Electric Lighting Acts, to the Board of Trade for a provisional order authorising them to supply electricity for public and private purposes within the urban district of East Grinstead. The letter was referred to the General Purposes Committee in order to ascertain what rights the Council had to protect.

Rontgen Rays.—The natural research department of the Animals Institute, under the auspices of Sir Henry Hawkins, president, and Prince Edward of Saxe-Weimar, are offering gold medals and other prizes for improvements in the X rays to aid the diagnosis of disease and lameness, and for the best developed photographs of the limbs and internal organs of the human being and the lower animals. Applications should be made to Prof. Matthews, 75, Kinnerton-street, Wilton-place, S.W.

Newport.—A Local Government Board enquiry was held at the Town Hall Newport, on Tuesday, by Mr. F. H. Tulloch, M.I C.E., one of the Government inspectors, with reference to an application by the Newport Corporation to borrow £12,000 additional for the town's electric light installation, making, with the £28 000 already sanctioned, £40,000. The Board of Trade have appointed Mr. Hugh Erat Harrison, principal of the Electrical Standardising Institution, Charing Cross-road, E.C., electric inspector to the Corporation.

Keswick.—An adjourned meeting of the Urban District Council has been held to discuss the electric lighting question. Memorials, signed by about 180 ratepayers, were read requesting the Council not to take any further steps with regard to purchasing the electric lighting company's works until the ratepayers had been consulted. After a somewhat stormy discussion it was ultimately decided that a committee of five be appointed to consider the report and the company's proposal, and to report to the next monthly meeting of the Council.

Kingswood (Bristol).—At a meeting of the Urban District Council a letter was read from the Western Counties Electric Lighting Company, stating that if the Council were going to do anything in the matter of purchasing the electric plant they should do so at once, and the matter must be brought to a speedy and definite decision. The letter was signed by the chairman of the company (Mr. H. Daniell). Following the advice of their solicitor (Mr. Seymour Williams), the Council decided to leave the matter in abeyance.

Windermere.—The Urban District Council have decided to erect eight new electric lamps in Cooks House-road and at Troutbeck Bridge. The Telephone Company having failed to get permission from the owner of Calgarth to put their line of wires over the estate, and being unable to follow the main road from Cooks House to Troutbeck Bridge without contact with the telegraphic communication, applied for leave to carry the wire from Millerground across by Cooks House to Brow Head and thence down by the Sun Hotel to the main road again. The Council have granted leave on payment of a rental of 2s. 6d. per pole.

Harrow.—At the meeting of the Urban District Council a letter was read from the Board of Trade enclosing a copy of a letter they had addressed to the Harrow Electric Light Company, who had applied for an extension of time so that the compulsory works could be completed. In their letter the Board of Trade said they had no power to extend the time, but under the circumstances they would allow six months to pass from the 3rd prox. for the consideration of the question of revoking the order. The Clerk said that was apparently their way of granting extensions.

Appointment Vacant.—The School Board for London are about to appoint an assistant science demonstrator, who will be required to visit schools under the direction of the Board for the purpose of giving instruction in mechanics. Salary £130, rising by £5 per annum to a maximum salary of £175 per annum, together with expenses not to exceed £75 per annum. Applications, which must be made on forms to be obtained from the clerk of the Board, must reach the clerk of the Board, School Board for London, Victoria-embankment, W.C., not later than Saturday, July 4, 1896, marked outside "Assistant Science Demonstrator."

Edinburgh.—Sheriff Rutherford has issued an interlocutor in an action for damages for breach of contract raised in the Edinburgh Sheriff Court by Mr. A. A Rose, 26, Regent-terrace, Edinburgh, against Smiths and Co., Limited, electrical engineers, 89, George-street, Edinburgh. The plaintiff claimed the sum of £29. 6s. as loss sustained by him through the defendants' failure to execute their contract with expedition. The sheriff, *inter alia*, found that the plaintiff's house should have been ready for occupation at least a fortnight sooner than it was, and therefore found the defendants liable in damages, which he assessed at £21. 6s and expenses.

Electric Lighting Machinery.—We have received from Messrs. G. E. Belliss and Co., of Birmingham, an illustrated catalogue of the high-speed electric light engines for which they are so well known. The catalogue chiefly refers to the self-lubricating type. which has proved itself so efficient for lighting and power work generally that Messrs. Belliss have been obliged to greatly extend this department of their works and to add a very complete new testing-house to enable dynamo machinery of all sizes to be thoroughly tried under working conditions before being despatched. They have already built or have under construction engines of this type developing nearly 30,000 h.p.

Hull.—At a meeting of the Finance Committee of the Corporation, the question of the proposed extension of the electric light in the borough, and the suggested borrowing of £42,000, came up for consideration. The borough treasurer (Mr. Milner) presented a report, and the Chairman explained that the borrowing of £42,000 would not incur any additional charge upon the rates of the borough. He moved that the report be adopted, and that the sanction of the Local Government Board be asked for borrowing the £42 000. The Chairman of the Electric Lighting Committee said that the extension was an absolute necessity, and he deprecated that time should be lost. The report was adopted.

London, E.—After investigations extending over a year, the Special Electric Lighting Committee appointed by the Mile End Vestry presented their report last week The committee find that the proposal to utilise the waste heat of the dust destructors for the purpose of generating electricity has not been successful. At Brighton it was found that the charge for electricity was only equal to 2s. 3d. per 1,000ft of gas, and that it was hoped soon to supply electricity cheaper than oil, and that last year a net profit of not less than £6,000 had been made. After having fully considered the information obtained, the committee are of opinion that it is advisable to light the hamlet by electricity, and recommend that application be made to the Board of Trade for a provisional order to enable the Vestry to do so.

Dublin.—As we announced last week, the Dalkey Electric Tramway has been purchased by the Dublin United Tramway Company for £273,000. The line will be worked by a Board consisting of members of the Thomson-Houston Company and of the Dublin United Company, Mr. William Anderson acting as secretary and manager, and this arrangement will be continued till the amalgamation of the undertaking is finally completed. We understand that as soon as the Dublin United Company obtain their Bill now before Parliament for leave to lay down lines in the Clontarf township, the works will be promptly carried out under the three-phase system now in operation for the Dalkey service. A new power station will, however, have to be built at Clontarf if no authority can be got to lay the cable from Ballsbridge.

Walsall.—A special meeting of the Town Council has been held to pass a formal resolution—pursuant to the powers conferred on the Council in that behalf by the Walsall and District Tramways Orders 1880 to 1884, the Staffordshire Tramways (Extension) Order of 1882, and the South Staffordshire Tramways Act of 1889, or some or one of them—in favour of the Council, with the approval of the Board of Trade, requiring the South Staffordshire Tramways Company to sell to the Council so much of the undertaking of the company as is within the borough of Walsall. The town clerk, in the name and on behalf of the Council, was authorised to give notice, under the common seal of the borough, to the South Staffordshire Tramway Company, requiring them to sell, and to take all other necessary proceedings for enabling the Council to put in force the compulsory powers of purchase now vested in them.

Manchester. — At the meeting of the City Council, Mr. Alderman Higginbottom moved the adoption of the annual report on the electric light, which showed, he said, in spite of the reduction in price from 8d. to 6d. per unit, a profit for the year of £11,138. The actual profit was £14,629, but it had been thought advisable to place the sum of £3,900 to what was called renewals

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account for replacement of plant. One gratifying feature of the year's work was the increased use of electricity for motor purposes. The extensions of the plant and mains at present in progress would soon be completed, but if the demand continued to increase as at present, still further extensions would be needed next year. For the purpose of a getting a day load, the current was sold for motive purposes at from 1½d. to 2d. per unit, according to the quantity used. Several large establishments took the current on such terms. The report was adopted.

Glasgow.—The past year, which is the first full year the tramway have been worked by the Corporation, has been one of steady progress. The traffic receipts have amounted to £328,827, and other receipts to £5,550, making a total of £334,377. The working expenses amounted to £251,110, leaving a balance of £33,267, which has been disposed of as follows: interest on capital, £12,657; sinking fund, £10,542; payment to common good in lieu of mileage rate, etc., £9,000; depreciation written off capital, £17,809; permanent-way renewal fund, £17,000; and general reserve fund, £16,259. The Sub Tramway Committee on traction have agreed to recommend the Tramway Committee as an experiment, to immediately construct an installation on the overhead electric system on the Kelvinside-Dennistoun route. It is understood that the chief objection to the underground conduit system, which was also considered, was the extra initial outlay that its construction would involve, and also the fact that so far it was only in its experimental stage.

Westminster.—At a Vestry meeting the Libraries and Baths Committee reported that they had caused a specification to be prepared by the surveyor for improving the electric lighting installation, which had proved to be insufficient when fully in operation in the libraries and the baths at the same time. They had caused tenders for the proposed work to be obtained from six firms, the lowest of which amounted to £358. As this amount exceeded their expectations, they had ordered that enquiries be made as to the possibility of detaching that part of the installation which lighted the library, and obtaining current from the company supplying the district. The committee hoped to find that course more economical, as preventing the large outlay required for increasing the accumulators and for running the dynamo when, as is frequently the case, the light has to be generated exclusively for the library. As the matter had become urgent, the committee recommended the detachment and the supply of the library by a public company. After some discussion the report was adopted.

London Lighting Extensions.—The London County Council have given their sanction to the following notices: The Charing Cross and Strand Electricity Supply Corporation to lay mains in Leicester-square (one side) Spur-street, New Coventry-street, and in Whitcomb-street and across it in two places; the Vestry of St. Pancras to lay mains in Gray's-inn-road, Chalk Farm-road, Judd-street, and Cromer street; the House-to-House Electric Light Supply Company to lay high and low tension mains in Cromwell-road, and a low-tension main in Cromwell-road West; the London Electric Supply Corporation to lay distributing mains, consisting of lead-covered cables drawn into cast-iron pipes, in Blackfriars-road and Upper Ground-street, and in King's road and Flood-street, Chelsea; the St. James and Pall Mall Electric Light Company to lay mains in Pall-mall-place and across Pall-mall; the County of London and Brush Provincial Electric Lighting Company to lay low-tension mains on the west side of Goswell-road. The Vestry of Islington, under the provisions of the Islington Electric Lighting Order, 1893, gave notice of intention to lay mains in Holloway-road, Caledonian-road, North-street, Wharfdale-road, and Wellington-road; but the Vestry is the undertaker under the order, and the Council has no power of approval or disapproval of these works.

Exeter.—The Special Committee on Electric Lighting reported to the City Council at the last meeting on the arrangements to be made for the future working of the undertaking. The committee were of opinion that it was desirable that, in addition to supplying the light, the Council should be in a position to supply and repair electrical fittings in the houses of their customers. The committee recommended that the electrical lighting works department be considered one of the departments of the work of the Council, under the control of the surveyor; that an electrical engineer be appointed in charge of the works who should be responsible to the city surveyor for the conduct and work of his subordinates; that Mr. Munro, the present electrical engineer to the company, be appointed electrical engineer at a salary of £200 per annum; and that the following staff be also appointed: leading engine-man, £2 per week; second engine-man, £1. 10s. per week; three stokers, at an aggregate of £3. 12s. per week; one foreman jointer, £2 2s. per week; four electricians, £70, £60, £52, and £52 respectively. It was decided that the staff should not exceed the number mentioned in the report, and it was also decided to advertise for an electrical engineer at a salary of £200 per annum, rising £10 annually to a maximum of £250. With these alterations the report was adopted.

Hampstead.—At the meeting of the Vestry, Mr. Reed said that the liberal laying of electric lighting mains—the Vestry had laid mains in nearly every road they had been asked to—was producing a good result. At the present time about 25 miles of distributing mains were laid. The number of customers taking the light had been increased by about a hundred since Christmas. At that time 261 applications for the light had been received, and of that number 255 were then connected. Now the total number of applications amounted to 385, and 355 connections had been made. There was now an equivalent of 25,292 8-c.p. lamps being supplied as compared with 19,407 at Christmas. Upon the recommendation of the Lighting Committee mains for the supply of electric current to private consumers were ordered to be laid in Shoot-up-hill, St. John's Wood-park, and a small portion of Belgrave-road. It was also decided that, during the pleasure of the Vestry, the high and low tension cables required for future extensions of the electric supply be ordered from the British Insulated Wire Company at the schedule of prices quoted by them, subject to their entering into a proper contract to supply the same. The Lighting Committee recommended that the Willesden District Council be informed that the Vestry are not prepared to entertain the suggestion of the Council that the lighting of the High-road, Kilburn, might be carried out by each authority, in the sections now repaired by them, by electric lighting or such other method as each might deem desirable. This was adopted. It was also decided with reference to the letters from the Westinghouse Electric Company, Limited, as to the system of supply used by the Vestry coming within the claims of the Hopkinson patent, and as to granting a license, that the Vestry should deny any liability in the matter of such patent. In reply to a question respecting the charge to the electric lighting account for repairs executed by the surveyor's department to the trenches in which the electric light cables are laid, Mr. Williams said that the charges were made in just the same manner as they would be to a public company under the same circumstances.

Hammersmith.—The Electric Lighting Committee having considered the tenders for electric lighting works brought up the following report at the meeting of the Vestry: "The work has reference to (*a*) supplying and laying high-pressure and low-pressure cables and pipes; (*b*) the supply and erection of arc lamps and lamp-posts; (*c*) the supply and erection of transformers and sub-station equipment; (*d*) the supply and erection of a five-ton overhead travelling crane. With regard to Schedule A, there are eight tenders, and the prices range from £9,526. 10s. to £16 096. 19s. The engineer has reported to us fully upon the tenders and we have also made the necessary enquiries; as the result, we recommend the Vestry to accept the tender of Callender's Bitumen Telegraph and Waterproof Company for Schedule A at the sum of £10,170. 2s. 11d. With regard to Schedules B and C, the tenders also vary; as to B, there are six tenders, the prices ranging from £2,672 5s. to £3,797, and as to C, there are seven tenders, varying from £857 to £1,155. We have also had a full report upon these from the engineer, and after very careful consideration we recommend the Vestry to accept the tender of Messrs. Siemens Bros., Limited, for Schedule B at £2,702 and Schedule C at £935. As to Schedule D the same remarks apply, and we recommend the Vestry to accept the tender of Messrs. Marshall, Fleming, and Jack, of Motherwell, Lanarkshire, for the supply and erection of the five-ton overhead travelling crane for the sum of £157, subject to the engineer receiving satisfactory replies to the enquiries he is making. According to the specification, firms tendering for Schedule A are required to give a guarantee through an approved guarantee society, at their own cost, to maintain certain insulation resistances for a period of five years from the date of completion of the works. Messrs. Callender write and inform us that they have applied to all the guarantee societies in London, and that they all decline to undertake this form of guarantee. Messrs. Callender offer to furnish the Vestry with two good and substantial sureties who will give the required guarantee, and under the circumstances we recommend that the Vestry accept the sureties, subject, of course, to our being satisfied after due enquiry." The tenders were accepted by the Vestry.

Nottingham.—Colonel A. G. Durnford, R E., an inspector under the Local Government Board, has held an enquiry with reference to the application of the Corporation for sanction to borrow £40,000 for purposes of electric lighting. Mr. H. Talbot, electrical engineer, stated that the works were started in 1892. He had designed the works and carried them out. The first sum of capital raised was £45,000. That sum of money was expended in the purchase of land, building, machinery, and mains. At the end of March, 1895, they had 8,267 8 c.p. lamps, and at the end of March, 1896, they had 15,466 lamps. On March 2, the date this application was made, they had 202 customers, the total number of lamps being 18,570. Applications were constantly coming in for extensions. In order to meet the requirements a large sum would have to be expended as capital. At the end of last winter the whole of the plant was utilised, and they got very near the limit. He had made an estimate of the cost of the extension, which would amount to £40,000. The demand was such that the Electric Lighting Committee had ordered him to go on with some portion of the works. There were several special applications which they must supply next winter. There were large buildings being erected, and no gas put in. There was also an application in connection with the new general post office, where about 1,000 lamps would be required. The Town Clerk added that the residents on the Nottingham Park Estate had informed the Corporation that unless they could supply the electric light within a reasonable time, the Duke of Newcastle would supply it himself. The following is the estimate of the amount of capital required to be borrowed for the extension of the undertaking: 162,900 cubic feet in buildings, consisting of engine-room, boiler-room, and coal-bunkers, and including foundations for engines and dynamos and boiler seatings and flues, at 8d. per foot, £5,430; five steel boilers, 28ft. long and 7ft. in diameter, for a working pressure of 150lb. per square inch, £2,125; steam main round engine and boiler rooms, with the necessary valves, separators, and drain pipes, £655; exhaust-main, floor plates, and frames, £280; pump injectors, feed-pipes, and connections, £382; blow-off pipes and connections, £65; lagging boilers and pipes

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with non-conducting composition, £150; one 80-h.p. steam dynamo, £700; one 135-h.p. ditto, £1,075; three 360-h.p. ditto, £6,900; steam and exhaust connections, £195; main switchboard, £600; cables for connecting dynamos to switchboard, £350; meters, £1,650; house connections, £900; motor transformers, £3,200; mains (underground), £14,300; contingencies, £1,043—total, £40,000.

Leeds.—At the meeting of the City Council this week Mr. Hannam (chairman of the Highways Committee) moved a resolution to the effect that upon the Royal assent being given to the Leeds Corporation Tramways Bill the Highways Committee be authorised to accept the following tenders for works in connection with the proposed electrical tramway from Roundhay to Kirkstall:

J. Russell and Sons, for poles and brackets	£3,607	0	0
Greenwood and Batley, for underground conduits and conductors	4,553	1	3
Crompton and Co., for trolley wires and attachments	3,370	0	0
Greenwood and Batley, for electric motorcars	14,000	0	0
Chloride Electrical Storage Syndicate, for accumulators and switches	1,341	0	0
Greenwood and Batley, for steam-engines	3,507	0	0
Greenwood and Batley, for dynamos, etc.	3,200	0	0
Clayton, Son, and Co., for boilers, etc.	1,371	0	0
J. T. Wright, for generating station	5,815	0	0

and that the sum of £3,541 be granted to the committee for foundations for engines and boilers, accumulator stations, fixing poles, etc. Mr. Hannam mentioned that Messrs. Crompton and Co. had withdrawn their tender of £3,370 for trolley wires and attachments, having made a mistake. The Council had therefore no alternative but to consent to the withdrawal. The next tender above it was £5,620, and if that were accepted it would add £2,250 to the estimate. He took it that the Council had no power to dispose of the matter now. It would be dealt with by the committee in the usual course, and would be brought up at the next meeting. He moved the acceptance of the tenders named with the exception of that of Messrs. Crompton and Co. Mr. Henry stated that, with one or two exceptions, the committee were practically unanimous in favour of the Corporation erecting a generating station, instead of taking the electricity from a company. The Corporation, he urged, should take the entire scheme into its own hands, and not allow a company to supply the energy, and thereby increase the value of its plant and enormously increase the amount which the Corporation would have to pay when they bought the concern from the company. Mr. Smithson moved as an amendment: "That, in view of the offer of the House-to-House Electricity Company, Limited, to supply electricity at the rate of 1½d. per Board of Trade unit, the tenders for engines, boilers, and generating station be referred back to the Highways Committee for further consideration with a view to their coming to terms with the company." The amendment was lost, and the original resolution was carried by 44 votes to 8. Owing to the improvements which have been brought about in recent years, the cars will weigh some three tons less than those now running along Roundhay-road. The poles and brackets have been designed by Dr. Hopkinson, the Corporation's electrical engineer, and they will present a decidedly handsome appearance.

Southampton.—At the meeting of the Town Council, Mr. Lemon, in accordance with notice, proposed "That the Works Committee negotiate with the Southampton Tramway Company as to the purchase of the tramways in the borough, and report thereon to the Council." The Tramways Act, 1877, said if the Corporation should apply to Parliament the company should not oppose, but should assent thereto and do everything necessary to obtain the power; but they could not make application for the purchase of these tramways later than 21 years after the passing of the Act. It was therefore absolutely necessary, if the Corporation determined to purchase this undertaking, that they must do so before August 10, 1898, and it would be seen from the Act that it was necessary that the Council should go to Parliament for the purchase, and the terms of purchase should be determined by agreement under the Lands Clauses Consolidation Act. Assuming that they determined to purchase that day, it would be necessary to go to Parliament this year. They must give notice in November, and they would not get the Royal assent till about August, 1897, so that would only leave 12 months to make the necessary arrangements for the working of the tramways. If they postponed action till next year they could not go to Parliament until the following November, and the result would be they could not obtain their powers till August, 1898, which was the time when the Act expired, so that if they delayed for a year they would have no margin to come to an arrangement, and the result was that their powers might lapse. So it was absolutely necessary, if they determined to purchase, that they should go to Parliament in November next. He was not going to commit the Council to an opinion as to the best forms of purchase, but to show the two kinds of purchase adopted in other places. The first was to purchase the permanent way of the tramway only, and lease it to the existing tramway company at a rental, the company to do all repairs, the rent to be paid by the tramway company to be a percentage over and above the amount to be paid by the Corporation to repay the principal and the interest of the loan to be obtained, so that the Corporation would have a profit. That was the principle that had been adopted at Portsmouth. The second mode of acquiring was to go to Parliament, and, failing agreement, to go to arbitration under the Lands Clauses Consolidation Act; but the result would be that they would have to purchase the whole undertaking and work it themselves. He was not going to express an opinion as to the different modes of purchase, but would ask the Council to refer this question to the Works Committee, giving them power to negotiate with the tramway company with the view to purchase. There was an additional reason why they should take action now, and it was because the Corporation had to all intents and purposes purchased the electric light company and no doubt they would get the consent of the Local Government Board—and when the committee put up the standards for lighting the town they should put up such standards as would answer the purpose of putting overhead wires, so as to work the trams by electricity. All these things would have to be considered, so as not to have to do things twice over. He wished members of the Council had gone to Hamburg to see the beautiful way the trams there were worked by electricity. He and others rode round the city and knew how beautifully they worked, and if the Council decided and came to terms to purchase and let the tramways to the company, they could come to terms with the company that they should charge so much per unit for the electric current. The result would be an advantage to the town in every way. If they granted the power to the committee to negotiate it would depend upon what terms they could come to, and if they did not purchase there would be an end of the matter. He did not know the views of the tramway company, but wanted to make enquiries. Senior Bailiff Walton seconded the proposition, stating that the question of the actual terms would be a matter for the committee to consider and report to the Council upon. He believed it would be a step in the right direction whether they leased or kept the tramways in their own hands, but, above all things, the permanent way should be in the hands of the Corporation to carry out the necessary repairs. The proposition was carried unanimously.

Birmingham.—The Public Works Committee have issued their report with respect to the application from Mr. R. Harding Milward, acting on behalf of Messrs William Mackenzie, of Toronto, and James Ross, of Montreal, the president and vice-president respectively of the Toronto and Montreal Street Railway Companies, for the consent of the Corporation to an assignment to them and a company to be formed by them of the leases now held by the Birmingham Central Tramways Company from the Corporation, to the subsequent surrender of such leases, and to the granting to the new company of a new lease or leases of the tramways for a fresh term of 21 years. The total length of line is 27 miles 34.7 chains, and the certified cost is £141,597. 1s 11d. The deposits with the Corporation amount to £68,580. 2s. 3d. The rent for the first 14 years of current leases is £5,663 17s., and for the last seven years £7,079. 17s. The annual sinking fund payment is £4,061. 8s. In addition to the rental, the company pay the actual cost of repairing the tramways, as certified by the city surveyors. In reporting their conclusions on the whole subject, the committee say: "(1) That they have not sufficient experience of the working of tramways by municipalities to guide them as to the probability of the Corporation desiring to take the tramways into their own hands at the expiration of the existing leases; (2) that the experiments being made in methods of traction, autocars, etc., render it desirable that for the present the tramways should continue to be worked by lessees, under such covenants for ensuring cheap and quick transit, and the safety, comfort, and convenience of the public as may be thought necessary; (3) that the Corporation would not be justified in rejecting the immediate and prospective advantages which they and the public would derive from the acceptance of the present offer. The principal advantages to be derived from complying with the request of Messrs. Mackenzie and Ross upon the conditions which your committee have provisionally arranged are: (1) the immediate abolition of steam traction and the substitution of overhead or underground electric or other improved system of traction to be approved by the Corporation, with smaller and more sightly cars, and a quicker and improved service; (2) the introduction of ½d. fares for short distances, and the reduction of fares for long distances; (3) a reduction of the working hours of the men; (4) an immediate increased rental to the Corporation. The profit of the Corporation upon the existing leases is estimated during the remaining portion of the first 14 years of the leases, after paying capital charges, at ½ per cent. per annum on the cost of construction, or about £700 per annum, and during the last seven years of the leases at 1 per cent., or about £1,400 per annum. Under the proposed terms the Corporation would at once receive £5,000 per annum, and a proportionately larger sum if any new lines are constructed, all the capital charges being borne by the lessees. It must not be assumed that the committee are opposed to the principle of municipalisation. They gave full consideration to this aspect of the question, but inasmuch as the present leases do not expire till 10½ and 15 years hence respectively, present municipalisation could only be effected by the Corporation purchasing the existing leases, and expending a very large capital sum in addition for reconstruction, in a similar manner to that proposed by the syndicate. This expenditure your committee could not recommend to the Council, nor, in their opinion, would the Council accept such a responsibility. The alternative then remained of leaving the existing leases in the hands of the present company until their expiration. The adoption of this course offers the prospect of a comparatively limited improvement in the present services and no reduction of fares or of working hours to the men. Your committee believe that by the acceptance of the offer of Messrs. Mackenzie and Ross upon the conditions which have been provisionally agreed, the Corporation and the public will derive all the advantages which they could reasonably anticipate from the working of the tramways by the Corporation, while they will run none of the risks which are

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inevitably associated with such an undertaking. By adopting the scheme now recommended by the committee the use of steam will be at once abolished, the tramways will be reconstructed without increasing the Corporation debt, a reduction of fares will be secured, a reduction of the working hours of the men will be obtained, and a substantial annual contribution will be made in relief of the rates. These advantages will be at once secured, at the cost of deferring the possibility of the municipalisation of these lines for a period of 10 years. The balance of advantage to the city seems to the committee clearly to lie in accepting the scheme now proposed."

PROVISIONAL PATENTS, 1896.

JUNE 22.

13723. Improvements in and in connection with incandescence electric lamps. Gustav Germer and Friedrich Arno Hüller, 89, Chancery-lane, London. (Complete specification.)

13729. Improved process for telegraphing with Morse apparatus. Luigi Cerebotani and Max Bernstein, proprietor of the firm of Joh. Friedr. Wallmann and Co, 111, Hatton-garden, London. (Complete specification.)

13730. Improved solenoid for electric arc lamps. Moriz Baumer, 111, Hatton-garden, London. (Complete specification.)

13767. Improvements in dynamo-electric generators, motors, and transformers. Eugenio Cantano 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc, Act, 1883, Sec. 103, February 11, 1896, being date of application in Italy.) (Complete specification.)

13775. Improvements in polyphase electric motors. Henry Pieper, Fils, 47, Lincoln's-inn-fields, London.

JUNE 23.

13814. Improvements in electric tramways. James Enright, 202, Holland-road, Kensington, London.

13824. A standard of electromotive force or potential difference. Walter Hibbert and Tyson Sewell, 14, Goldhurst-terrace East, South Hampstead, London.

13847. Improvements in and relating to electro-mechanically operated gas-lighters and the like. James Tarbotton Armstrong and Axel Orling, 64, Aldersgate-street, London.

13889. Improvements in and relating to electrical distributors. Louis Kling Oppenheimer, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

13891. Improvements relating to incandescent electric lamps. Cornelis Alewijnse and Roothaan Alewijnse and Co., 322, High Holborn, London.

JUNE 24.

14005. Apparatus for automatically closing and opening by electrical agency the barriers of railway level crossings. Christiaem Cornelius van der Valk, 28, Southampton-buildings, Chancery lane, London. (Complete specification.)

14014. An improved electric cooking and frying or roasting apparatus. George Cecil Dymond, of the firm of W. P. Thompson and Co., 6, Lord-street, Liverpool. (The Chemisch-Elektrische Fabrik "Prometheus" Gesellschaft mit beschrankter Haftung, Germany.) (Complete specification.)

14015. Improved electric heating devices. George Cecil Dymond, of the firm of W. P. Thompson and Co., 6, Lord-street, Liverpool. (The Chemisch-Elektrische Fabrik "Prometheus" Gesellschaft mit beschrankter Haftung, Germany) (Complete specification.)

14020. Improvements in electrically-propelled velocipedes. Clovis Pierre Francis Clerc and Adolphe Georges Pingault, 45, Southampton-buildings, Chancery-lane, London.

JUNE 25

14064. Central battery telephone exchanger system. Daniel Sinclair and William Aitken, 62, St. Vincent-street, Glasgow.

14092. Improvements in electric motors especially applicable to the propulsion of velocipedes and motorcars. Clovis Pierre Francis Clerc and Adolphe Georges Pingault, 45, Southampton buildings, Chancery-lane, London.

JUNE 26.

14157. An improved form of washer for use in connecting secondary battery lugs and other electrical conductors. John Somerville Highfield, 6, Ingestre-road, Stafford.

14187. A portable electric drill. Ernest Holmes and Siemens Bros. and Co., Limited, 28, Southampton-buildings, Chancery-lane, London. (Complete specification)

14197. Improvements in or relating to incandescent electric lamps. Cornelis Alewijnse and Roothaan Alewijnse and Co., 322, High Holborn, London.

14220. Improvements in electrically-heated radiators. William Brooke Sayers, 46, Lincoln's-inn-fields, London.

SPECIFICATIONS PUBLISHED.

1890.

11480. Dynamo-electric machines, etc. Thomson. (Second edition.)

1891.

3748. Slabs, etc., for electric insulators, etc. McLean. (Second edition.)

1894.

4454.* Telephony and telegraphy. Adams-Randall. (Amended specification.)

4572.* Telephonic transmitters. Adams Randall. (Amended specification.)

1895.

10951. Secondary batteries. Freund.

11976. Electric safety lamps. Headland.

12030. Electric arc lamps. Davy.

12373. Electric lamps, etc. Hacking and Brand.

12871. Electrical circuit closers. McEvoy.

13618. Electrically-actuated mechanism. Beevor.

14342. Electrolysing apparatus. Kolbe and Lambert.

14476. Telephones. Libbey.

23404. Electric motor. Zapata.

1896.

719. Electric accumulators. Willcox. (Société l'Accumulateur Fulmen.)

1238. Electric batteries. Newton. (Willms.)

4632. Dynamo-electric generators and motors. Royce and Claremont.

5298. Electric flash-light apparatus for photography. Boult. (Bruns.)

5703. Arc lamps. Boult. (Jolles and another.)

7013. Electric meters. Devonshire. (Steinmetz.)

7038. Arc lamp regulators. Baurlin.

7161. Electric light fittings. Chapman.

7566. Electric railways. Reagan.

7557. Commutator brushes and brush-holders. Hirsch and others.

8210. Electric arc lamps. Fisher.

9528. Telegraphic relays, etc. Lake. (Burke.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5¾-6¼
Brush Company, Ordinary	3	1⅛-1⅜
—— Non. Cum., 6 per cent. Pref.	2	1½-1¾
—— 4½ per cent. Debenture Stock	100	112 115
Charing Cross and Strand	5	8¼ 8¾
Chelsea Electricity Company	5	7½-8
—— 4½ per cent. Debentures	100	114-116 xd
City of London, Ordinary	10	14½-15½
—— 6 per cent. Cumulative Pref.	10	16½-17
—— 5 per cent. Debenture Stock	100	152-156 xd
City and South London Railway, Consolidated Ordinary	100	43-45
—— 4 per cent. Debenture Stock	100	135-137
—— 5 per cent. Pref. Shares	10	4¾ 5¼
County of London and Brush Provincial Co., Ordinary	10	8¾-9¼
—— 6 per cent. Cum. Pref.	10	13¼-13¾
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2¼
Edison and Swan United Ordinary	3	1¼-1¾
—— 4½ per cent. Debentures	100	103-106 xd
Electric Construction, Limited	2	1¼-1½
—— 7 per cent. Cumulative Pref.	2	2½ 3
Elmore's Copper Depositing	2	¼-¾
Elmore's Wire Company	2	⅜ ⅝
W. T. Henley's Telegraph Works, Ordinary	10	17-18
—— 7 per cent. Preference	10	17-18
—— 4½ per cent. Debentures	100	109-114
House-to-House Company, Ordinary	5	4 4½
—— 7 per cent. Preference	5	8-8½
India Rubber and Gutta Percha Works	10	21-23
—— 4½ per cent. Debentures	100	105-108
Isle of Man Electric Trams, Ordinary	1	1⅛-1⅜
—— 6 per cent. Preference	1	1⅛-1¼
Kensington and Knightsbridge Ordinary	5	9-9½
—— 6 per cent. Pref.	5	7½-8
Liverpool Electric Supply, Ordinary	5	8-8½
Liverpool Overhead Railway	10	14-14½
—— 5 per cent. Pref.	10	17¼-17⅝
—— 4 per cent. Mortgage Debentures of £100	100	112½-114½ xd
London Electric Supply	5	1-1½
Metropolitan Electric Supply	10	13½-14½
—— 4½ per cent. First Mortgage Debenture Stock	100	119-121 xd
National Telephone, Ordinary	5	7⅜-7⅝
—— 6 per cent. Cum. First Pref.	10	17-19
—— 6 per cent. Cum. Second Pref.	10	16½-17½
—— 5 per cent. Non. Cum. Third Pref.	5	6¾-7
—— 3½ per cent. Deb. Stock	100	105-108 xd
Notting Hill Company	10	9½-10
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8¼-8¾
—— £4½ shares	4½	7¼-7¾
Oriental Telephone and Electric Company	1	¾-⅞
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	105-107
Southampton Electric Company	5	4¾ 5¼
St. James's and Pall Mall, Ordinary	5	11¼-11¾
—— 7 per cent. Pref.	5	9½-10½
Telegraph Construction and Maintenance	12	38-41
—— 5 per cent. Bonds	100	102-105 xd
Waterloo and City Railway, Ordinary		8-8½ xd
Westminster Electric Supply, Ordinary	5	10¼-10¾
Yorkshire House-to-House	5	7⅜-8

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NOTES.

Obituary.—The death has been announced of Dr. Alexander Stoletoff at the age of 57. Dr. Stoletoff was professor of physics at the University of Moscow and the author of several contributions to the theory of electricity and electromagnetism.

Society of Engineers.—A visit was made by a party of the members of the Society of Engineers on Tuesday to the M. S. and L. Railway extension to London works (Rugby to Byfield section). Among those present were: Mr. W. Worby Beaumont, vice-president; Mr. A. T. Walmisley, past-president; Mr. George Burt, and Mr. Percy Griffith.

Canadian Electrical Association. — The sixth annual convention of the Canadian Electrical Association was opened at Toronto on June 17. The attendance was one of the largest in the history of the association. Mr. A. B. Smith, superintendent of the Great North-Western Telegraph Company, the president of the association, occupied the chair, and delivered the presidential address. The convention lasted three days. Next year it will meet at Niagara Falls.

New Aluminium Alloys.—Mr. Moissan has obtained quite a quantity of new alloys by projecting a mixture of the oxide of the alloying metal with powdered aluminium into a bath of liquid aluminium. Alloys of aluminium with nickel, molybdenum, tungsten, uranium, and titanium have been obtained in this way. An amount of heat is set free by the reaction, but this is probably only due to oxidation of the melted aluminium, and does not necessarily indicate that the alloys are chemical compounds.

Tramways in America.—The Chicago *Electrical Journal* says that one by one, and rapidly, the "cable roads in the large cities" are changing to electricity. But on the same page it is stated that the Nantasket Beach road has abandoned the overhead trolley in favour of the third rail. The opinion of our contemporary appears to be that "the overhead trolley will not do, and the third rail will not do except for elevated construction," but it thinks great things of an underground trolley system, "the so-called conduit."

Electrical Standardising Institution.—As a result of the recent scholarship examination the following awards have been made by the Board of Control of the Electrical Standardising, Testing, and Training Institution, Charing Cross-road, W.C.: to Mr. R. Pearson Russell, of the Royal Academy, Woolwich, a Maxwell scholarship of 50 guineas, tenable for two years; Mr. E. A. Thompson, of Dulwich College, an exhibition of 35 guineas, tenable for two years; and Mr. John Petrie, of Carlisle Grammar School, Mr. H. K. Rodwell, of Felsted School, and Mr. C. C. Hurford, of Epsom College, prizes of 20, 10, and 5 guineas respectively.

Parisian Novelties.—According to the *Revue Industrielle*, an electric boat has been constructed for the purpose of visiting and inspecting some of the large sewers. The boat is warped with a chain which it picks up as it goes along, according to a practice employed elsewhere in France, and the motive power is a Fulmen accumulator battery. Another journal announces that a number of the Paris policemen have been provided with electric "bullseyes." Whether this is done to get an extra powerful light or not is not stated. The tiny incandescent lamp for ticket collectors has been seen spasmodically in London omnibuses and on ticket platforms for some time.

Very Temporary Construction.—The *Times* correspondent with the Soudan expeditionary force, writing from Ferkeh on June 15, says: "At this end the Egyptian and black troops are constructing the railway formation at such a rate that the engineers surveying the line have difficulty in keeping ahead of them. The telegraph wire was brought here on the 10th, and will be at Suarda within a few days. For a great part of the way the non-insulated wire is merely laid on the sand, which in this dry country is an absolute non-conductor of electricity." It would be interesting to have added what is considered "good earth" for such a line—probably water.

Bankside Station.—It may be worth note that the current number of the *Revue Industrielle* begins with a description of the City of London Company's system, with illustrations and plans of the Bankside works. Mention is made of the parallel running that was done with the Wool Quay temporary station. To a foreigner, who would hardly be supposed to know the relations as to area and government of the "City" to the rest of London, the opening words of the article might easily prove misleading. They are: "The city of London is divided for public and private lighting into three districts, of which the most important, the eastern one, is worked" by the company above referred to.

Electric Lighthouses.—In reference to what has been said in previous notes with regard to the "penetrating" power of the Ushant lighthouse and the loss of the "Drummond Castle," it may be worth adding that it now appears, on information derived from the Inspector-General of the French Lighthouse Service, that at the time of the wreck both the Ushant light (electric) and the Ushant Stiff oil light (which is a 22,000-c.p. one) were equally invisible at a distance of three miles. The attempt to use the disaster to the "Drummond" as a means of reviving the controversy as to electric *versus* gas or oil lighting for lighthouses was therefore, as we pointed out the time, quite unwarranted by the probabilities or facts of the case.

Electric Traction.—The French Society of Civil Engineers have been lately much occupied with the question of the possible adaptation of electric traction to railways. The question has been examined from the point of view of obtaining a high speed in a paper read there by Mr. E. de Marchena, who appears to think that the necessary generating stations along the line might undertake other work, such as lighting and power distribution. In the discussion which followed, Mr. P. Villain thought that a trolley system would not do for high speeds, but Mr. de Marchena said it had been used successfully in America for speeds as high as 36 miles an hour. Other speakers suggested that the trolley was capable of modification.

Nijni-Novgorod Exhibition.—The exhibition at Nijni-Novgorod was opened last month. That town is decidedly beyond the range of most European visitors, and there have been so many exhibitions lately that this particular one in Eastern Russia is likely to be very much overlooked. Not because of its smallness—it seems to be big enough, since the area occupied exceeds 200 acres. So far as electricity is concerned, Siemens and Halske and some other German firms are exhibiting. Electrical railways and electrical lighting have been introduced throughout the fair (that there is a fair there is all that most people know of Nijni-Novgorod), and extended between the town and the exhibition. A small electrical tramway has also been laid down in the grounds of the latter. There are also exhibits of electro-bleaching.

Storm at Oxford.—A severe thunderstorm passed over the Midland Counties on Wednesday evening. A good deal of damage was done at Peterborough, where there was an agricultural show going on, and at Oxford the Ashmolean Museum was struck and the roof set on fire. It was half-past six, and there was no one in the building, which was locked up, but fortunately the

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occurrence was noticed by some workmen, so that the fire was put out before any damage was done to the contents of the museum. Had the storm been a little later, the whole of the valuable contents of the library and picture galleries might have been destroyed. The building has four lightning conductors, but the discharge, instead of going to these, struck a gable, where a lead gutter and standpipe provided a good conductor to earth.

Personal.—The governing body of the Northern Polytechnic (London) has appointed as head of the department of electricity and electrical engineering Mr. V. A. Mundella, B.A. (Cambridge), B.Sc. (Durham), late Pemberton Fellow of the University of Durham. Mr. Mundella for the last five years has been one of the lecturers on physics and electrical engineering in the Durham College of Science, and has had considerable experience in connection with the erection and management of electrical installations. As head of the mechanical engineering department, the selection of the governing body is Mr. Alfred Garratt, of University College, Bristol, and as first assistant in the chemical department Mr. Thomas Ewan, B.Sc. (Vict.), Ph.D. (Munich). Since 1894 Dr. Ewan has been demonstrator and assistant lecturer in chemistry at the Yorkshire College.

University of London.—The Bill appointing a statutory commission to deal with the proposals for making the London University a teaching as well as an examining university, has been introduced in the Lords at last. But its introducer, the Duke of Devonshire, in moving the first reading, made use of the ominous words that he could not form any opinion whether the Bill could pass the other House this session, but he trusted it might at all events be passed by their lordships, and that an opportunity would be afforded for ascertaining the real character of any opposition that might be offered to the proposed change in the constitution of the university. If anything really is to be done—and most people are at least agreed that the present state of affairs is not satisfactory—there seems no particular reason why the Bill should not have been introduced at a much earlier period of the session.

Telephone Troubles.—A week or two ago we acknowledged the receipt from Oskar Leiner, of Leipzig, of a little book by Mr. Arthur Wilke on the "Mutual Influence of Telephone Lines" (Ueber die gegenseitigen Beeinflussungen der Fernsprechleitungen) according to Müller's theory. Müller's theory appears to be that cross-talking and all other telephone troubles arise from deficient insulation, and the use of the wrong sort of insulators. A great deal of space is therefore devoted to possible leakages between insulators on a pole line. The criticisms and objections to the theory that have appeared in the *Elektrotechnische Zeitschrift* and elsewhere are also given and replied to. The purpose of the book may be gathered from its concluding sentence: "But if Müller's theory is proved, the efficacy of Müller's method of prevention is a necessary consequence of that theory, and this theoretical efficacy is confirmed by the experiments described"—but we doubt the fact.

The Civil Pension List.—We are pleased to see in the list of new pensions recently laid on the table of the House of Commons the names of Mrs. T. H. Huxley and Mr. Oliver Heaviside. It is needless to refer to the claim the widow of Prof. Huxley has on the nation, and we are only too pleased to see the value of his life work thus acknowledged. The other recipient, although not equally illustrious, has devoted years of his life to unremunerative physical and mathematical research. Although Mr. Heaviside in most of his writings is unintelligible to the average reader, there is no doubt that he has done much to develop a new system of mathematical treatment which is highly appreciated by those who do understand it. The leaders in all new crusades of this kind which have not a direct application to the pocket of the people are apt to be sneered at by the practical man, and we are therefore exceedingly glad that Mr. Heaviside's arduous labours have been duly recognised.

German Prices for Current.—There is given in tabular form in the *Elektrotechnische Zeitschrift* particulars of the tariff for current at 36 towns. These are mostly in Germany, but Vienna, Copenhagen, Stockholm, and Christiania appear in the list. The figures are obtained from the Association of Delegates of Electricity Works, and relate to the year 1894-95. The usual price for lighting purposes appears to be 8pf. per hectowatt-hour, which is equivalent to something like 9½d. per unit; but heavy rebates are allowed in almost every case, depending on the quantity taken. The way in which these are calculated, however, differs so much that it is hardly possible to summarise them. A brief description of the system of supply is also given, from which it appears that more than three-quarters of the stations are continuous-current ones. It is also worth note that in a very large number of cases the municipality own both the gas and electricity works.

Electric Train-Lighting.—It is stated that the National Electric Car-Lighting Company, of New York, have so far interested the Pennsylvania Railroad Company in their method of railway-carriage lighting as to have got a practical test made by the railroad company on their line. The mechanism and power employed to produce 14 c.p. to 16 c.p. electric lights in railroad trains "is located and produced entirely on the truck of the car. The power is derived from the revolution of the car axles. Storage batteries, which are charged for five hours, but can run for 12, are also placed on the truck." Thus far, 4,000 miles have been covered by trains with this system of lighting, and it is stated on behalf of the National Electric Car-Lighting Company that "the system is coming up to the entire expectations of all parties concerned." If the Americans would use electric lighting and steam heating for their railroad cars, we should hear no more of those terrible fires which are the frequent sequel of a railway accident in the States.

Acetylene Motors.—A paper read by Mr. Ravel before the French Société technique de l'Industrie du Gaz at their meeting at Clermont-Ferrand last month is reproduced in the *Revu Industrielle.* Mr. Ravel has been going into the matter experimentally, and does not appear to think that the new illuminant is going to be any good for motor purposes. If a large proportion of acetylene is used in the working gas mixture the explosion is too violent for convenient use, while if the acetylene is diluted to avoid this the heating power is not what it might be. Mr. Ravel says, "Perhaps this gas will find its application in rotary engines or turbines, but on that path, thorny enough in itself, there are practical difficulties of the first order to be encountered." Why anybody should choose for a motor what is eminently an illuminating gas is not very clear. Moreover, acetylene has to clear itself of the suspicion, whether ill-founded or not, that when under pressure it may explode of itself. Mr. Ravel does not seem to have been quite happy himself on this point when in the course of his experiments he found his generator getting hot.

Water Power.—Commenting on Mr. A. Steiger's paper before the Institution of Electrical Engineers on the utilisation of water power, the New York *Electrical Engineer* says that the popular impression regarding the economy of water power is in very few cases actually

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realised in practice, or at least the economy is not what it would appear to be considering the energy is supplied free of charge. "It is almost impossible to make any general comparison between the cost of steam power supplied from coal and water power, although this is easily done in the case of any particular plant, but it is well known to engineers that where coal is reasonably cheap and the water power available needs considerable development, the former power is usually the more economical. Where natural conditions, on the other hand, are favourable, water power may offer great economy, but it is not by any means safe to assume this as a general rule." From this it would appear that the ideas on the subject expressed by most of the speakers when the paper was discussed hold good even under the much more widely varying conditions of the North American continent.

Vanadium Carbide.—If Mr. Moissan continues his investigations as to the reduction in the electric furnace of those elements not easily obtainable in the metallic state by ordinary means, we shall soon know precisely the behaviour of all the refractory and rare elements towards carbon. At present there seems to be something like a regular gradation according to Mendeleieff's law. As to vanadium, which occupies an important position in the series, Mr. Moissan says that "vanadium pentoxide, reduced in the electric furnace, gives a metal which always contains an appreciable amount of carbon. If the time of heating is as short as possible, a metal containing only 5 per cent. of carbon can be obtained. By prolonging the time of heating the percentage of carbon is increased to 18·5 per cent., indicating the formation of the carbide V C." This carbide is not attacked by water at the ordinary temperature. Vanadium will form alloys with iron, copper, and aluminium, but not with silver. When all the facts have been ascertained and tabulated, they will probably throw some light on the determining causes of the different properties of various samples of cast iron and steel.

High Temperatures.—There are three ways by which high temperatures may be measured. The first uses an air thermometer of refractory material; the second depends on the change in the resistance of a platinum wire with change in temperature; and the third is based on the employment of a thermo-couple of relatively infusible metals. According to Messrs. Holborn and W. Wien, in a paper published in *Wiedemann's Annalen*, the air-thermometer method was valueless until recently, as suitable vessels could not be made. But now these are produced from refractory clays, and permit of measurements up to 1,500deg. C. (2,732deg. F.). The results are, however, vitiated by the effects of capillarity in the interior of the vessel. The resistance method has also its disadvantages. At high temperatures the resistance generally increases, but the temperature coefficient is irregular. The presence of free hydrogen also affects the resistance. The third or thermopile method is favoured by the authors, who prefer a circuit of platinum and an alloy of platinum with 10 per cent. of rhodium. Temperatures up to 1,600deg. C. (2,912deg. F.) can be measured by it, and it is remarkably constant under various conditions.

Fencing.—The inventor of the new electric "Umpire" is Mr. Muirhead Little, a gentleman who is also known in the surgical world. In spite of its name, the invention is not for use in the cricket field but belongs to the school of arms, and its object is to overcome the difficulty of judging hits in a fencing bout. The end is attained by covering the front of each jacket with fine copper or brass wire gauze and connecting this with the adversary's foil through a circuit containing an electric bell and battery. When a hit is made the circuit is closed and the bell rings. A special arrangement in each foil-handle provides that only a direct point produces a ring. Two entirely electrically distinct circuits are used, one for each fencer, and the arrangements for producing contact are such that flicks, or blows, or grazes produce no result. The bells being of different tones and placed on opposite sides of the room, there is no difficulty in deciding who has scored a hit, or in cases of almost simultaneous hits who delivered the point first. By a simple arrangement the wires passing from the batteries to the combatants' collars are kept well out of the way however sudden may be their movements of advance or retreat. The apparatus has been tried by persons of authority in the fencing world, and there is said to be a complete absence of any restraint on the movements when using it. In spite, however, of a small number of earnest followers fencing is more or less of an exotic in this country. In this matter France sets the fashion, and the use of Mr. Little's invention will have to run the gauntlet of the Parisian schools, where a gibe about fighting at the end of a wire like a marionette on a string might be fatal to the best invention—particularly if it is not of French origin.

Direct-Current Power Transmission. — The electric lighting system of Brescia presents some peculiarities. To begin with, a continuous current at a high voltage is adopted for power transmission instead of an alternating one, and the dynamos are in series according to a practice that has been adopted in other places in Italy. The installation has formed the subject of a descriptive article in *L'Elettricità*, from which it appears that the generating station is at Calvagese, the motive power being derived from the Chiese. There are three 100-h.p. turbines and one of 200 h.p. Each of these is direct coupled to its dynamo. The dynamos are continuous current, and are run in series, and as the smaller machines are wound for 1,400 volts and the large one for 2,700 volts, it will be seen that something not far short of 6,900 volts (continuous) are transmitted over the line. The latter is 22 kilometres (17½ miles) long, and there is a drop of 700 volts. At Brescia the current is converted for purposes of public and private lighting by rotary transformers, of which there are at present six. The public lighting is by arc lamps in series. There are two sets of these, so as to allow about half to be extinguished at midnight. For the private lighting a three-wire system of distribution is adopted. Two batteries of 72 accumulator cells each are used in connection with the three-wire distribution system. The tariff for private lighting is about 6¾d. per kilowatt-hour, but the Government and municipal taxes bring this up to nearer 8d. Motors are provided for in the tariff, and, if used in the daytime only, are granted a reduced rate, but there are no details as to how many of them are in use or likely to be. The electrical part of the work has been done by the Compagnia dell' Industria Elettrica, of Genoa, and the works have been in operation since November last.

The Principles of Price.—Mr. Farnsworth, writing in the New York *Electrical Engineer* on the proper way of charging for electric lighting service, criticises as crude and inaccurate the methods in general use. All operating expenses, he argues, may be divided into three classes, based on the manner in which they could be proportioned among the customers. The first class contains items which should be shared equally by each customer irrespective of size, such as office expenses, meter readings, repairs, salaries, and wages. The second class is made up of expenses which should be divided among the customers in proportion to the size of their equipment, and includes interest, deprecia-

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tion, energy wasted in transformer cores, and extra labour during heavy loads; and the third class includes coal, oil, waste, ashes, loss in lines, machinery, repairs, and all operating expenses which are a function of the load. Each consumer should pay his proper share of each of the three classes of items, in addition to a certain profit for the company. The first and second classes should form a base-rate, to which is added the charge for current in the third item. All of this would be very nice if everyone was passionately attached to intricate book-keeping and picking out. But even those people who have a fondness for tabulating items have been known to be glad to get others to do the arithmetical work for them, and something very much more rough and ready is necessary for the average householder. Moreover, Mr. Farnsworth's classification would hardly go uncriticised. Why, for instance, should a customer with 10 lamps pay the same share of the "wages, salaries, and repairs" as one with a hundred lamps. Moreover, if you have laid mains for a big customer it is surely good business to get hold of the small customers on the way, even, if taken alone, their service would not have been remunerative.

The Telephone Service.—Letters continue to be published by the *Financial Times* with a view of showing what business men think of the telephone service. The following from "Bishopsgate" is a new complaint: "My companies have recently removed into offices in a large new building here. I have had the telephone for years, and gave orders for it to be removed to the new address. Months have passed, and I find the Telephone Company refuse to reinstate the telephone here because the landlords will not consent to give them carte blanche to erect on the roof of their building a huge structure for the general supply of the company's subscribers. The company evidently rely on their monopoly and the pressure the tenants can put on their landlords to have their own way. Is this business, or fair dealing, with subscribers who have actually paid their rent?" The *Financial News* has also taken up the subject. A correspondent writes: "I have had occasion lately to telephone through to my office from Brighton about 20 times, invariably before 11 a.m., and have never been put through under 15 minutes, and in most cases I have had to wait 25 and 35 minutes before being able to communicate with the office. Then, again, I have what is known as a pass-key, with a number to it, by which I can go to any public call-office, and by quoting the number get through at a reduced price, and yet when I go to the post office they say they know nothing about any pass-key or arrangements, and they want to make one pay the full price. Now, this, to my mind, is very ridiculous, because in the case of Brighton the post office and the telephone head office are in the same street, exactly opposite each other." Another correspondent complains that he can never get on to Kensington from the City under from 20 to 25 minutes, and has been told on more than one occasion that the number required (his own branch office) is not in existence. Further details follow which seem to show that all is not for the best at the best of all possible switchboards.

Carbon-Consuming Batteries.—It will be remembered that some time ago Dr. Coehn obtained what he believed to be a true solution of carbon in hot sulphuric acid, and proceeded to investigate the question whether a carbon-consuming cell could not be obtained in this manner. Dr. Coehn used lead peroxide on the other plate, but the results obtained have been subjected to serious criticism. To some of these criticisms Dr. Coehn has replied in the *Zeitschrift für Electrochemie.* Part of this is concerned in what really happens when an element passes into solution, and has only an inferential bearing on the practical question. Prof. Mendelejeff is quoted as stating that with a weak current through a liquid compound of chlorine and carbon powdered diamond is deposited on the negative electrode, but it is thought that he referred to the work of Despretz, who obtained a diamond powder on a platinum electrode by passing a weak current for two months through acidulated water. He also obtained green crystals on the positive pole by a weak current for six months through an alcoholic solution of a compound of chlorine and carbon, while on the negative pole there was a brown warty substance having the same hardness as diamond. It is also stated that traces of carbon are sometimes contained in the deposited metals in an electrolytic bath. All this, however, only shows what a very long way Dr. Coehn is at present off a practical solution of the problem. With reference to the Jacques hot soda cell, little further has been heard of it except that a company has been or is to be formed to exploit the invention. The American criticisms of it run on the obvious lines, and do not appear to be based on any closer acquaintance with the battery than the descriptions that have appeared from time to time. Of course the first question to determine is whether it is merely necessary to get the soda to a high temperature in order to secure the desired reaction, or whether heat is continuously absorbed from the furnace. The arrangement as it at present stands is obviously capable of improvement should the first supposition turn out correct.

Electrolytic Dissociation.—The *Journal* of the Chemical Society contains two abstracts from the *Zeitschrift für Physikalischer Chemie* which have some bearing on the theory of electrolysis. The first gives the results obtained by Mr. Georg Bredig on the subject of the kathion velocity in the case of the amines. These are closely analogous to those given by Höfker for the mean free path in these compounds in the gaseous state, the latter constant being obtained from measurements of the thermal conductivity of the gases. Both constants decrease with diminishing differences as the weight of the alkyl increases, and in metameric amines are greater the greater the number of alkyl groups united to the nitrogen. The author finds also that the thermal conductivity may be expressed as a linear function of the ion velocity, the observed and calculated numbers agreeing within the limits of experimental errors. The other abstract relates to the influence of electrolytic dissociation on molecular refraction. Messrs. Max Le Blanc and P. Rohland, in order to determine whether the hydrogen ion has a greater specific refraction than that of the combined atom, determined the difference between the molecular refractions of (1) weakly dissociated, (2) strongly dissociated acids and their sodium salts, which are in all cases strongly dissociated. In the case of formic, acetic, glycollic, propionic, butyric, glyceric, and lactic acids the difference in the molecular refractions varied between 3·08 and 3·72 (Gladstone), between 1·56 and 1·80 (Lorenz). For the more strongly dissociated acids, mono-, di-, and tri-chloracetic, nitric, and hydrochloric acids, the differences were 3·17 to 1·37, and 1·60 to 0·75, the number decreasing with dilution and dissociation, so that the hydrogen ion exerts a greater influence than the acid ion. The refraction of sulphuric and tartaric acids were found by Hallwachs to remain almost constant on dilution, a result probably due to the influence of the other ions. Experiments with bases were undertaken, but no similar conclusion regarding the hydroxyl ions could be established.

Motorcarts.—Motorcarts are at present much more talked about than seen, but that is probably inevitable until it is known what will be the final form of the Act to

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legalise their use on ordinary roads, and whether it will get passed this session or not. Some information as to the progress of the movement in favour of the adoption of these vehicles was given by Sir David Salomons at the meeting of the Self-Propelled Traffic Association on Wednesday. Sir David said that these were early days in the movement, and they would not expect to hear that a great number of members had joined the association, but their success, nevertheless, had exceeded what they had anticipated. They were adopting the principle of having local secretaries to forward their interests in various parts of England, and one, at least, had been appointed in Mr. Shrapnel Smith, at Liverpool. A communication was sent to the French Finance Minister to ascertain what concessions he would make to them for the entry of these carriages into France, and for permitting their reimportation into this country without inconvenience to the users. Information had been sent throughout France to the various Custom House officers that every facility was to be offered to the users of these carriages. No remission could be made in the tax, but on exit the money would be returned without unnecessary formality. The carriage, however, was not to remain in France for more than 12 months. He was anxious to show that they had at heart the interests of the users of these carriages, to make travelling a convenience to them, as well as the commercial side of the question, in bringing purchasers and vendors together. He hoped that the Locomotives on Highway Bill would be passed directly; and that the railway companies would be induced in connection with the movement for horseless carriages to undertake the collection of goods for various stations along their lines. He was a director of the South-Eastern Railway Company, and his colleagues had permitted him to order a carriage in order that an experiment might be made in this direction, and if it answered, he trusted that they would see it extended throughout the country.

Municipal Lighting in Michigan.—It appears from the columns of our contemporary the *Western Electrician* that the State of Michigan is supposed to have taken the lead in municipal lighting in America. As this paper is clearly not in favour of such a policy, which has been so successful in England, it is interesting to note the facts it is able to bring forward in support of its view. The Mayor of Detroit—a Mr. Pingree by name—is credited with the initiation of the policy when stumping the State for "gubernatorial honour." He then told the people that corporations were robbing them. Against the tendency to municipalise the electric light undertaking as advised by the above-named gentleman, the editor quotes the experiences of the Michigan township Marquette. The local conditions at this place were most favourable, and the concession for the use of water power was obtained on most advantageous terms. After this we are informed "it was the old story of political manipulation. The plant was started out with a blare of trumpets, the people were told that they were saving money; the deception was successful for a time, then the true conditions of affairs became apparent, and the city was confronted with the proposition of putting in additional money with the hope of saving, in part at least, the money already invested." Other cities, according to our contemporary, have had similiar experience, and "it is only a question of time when every community in the country that is operating its lighting plant will become convinced that this socialistic feature of city government has proved a costly experiment, and has encouraged and supported a horde of political heelers who could not secure employment with any commercial company." From the above and other statements too numerous to quote verbatim, we gather that the failures in America of municipal undertakings are due to the corrupt practices of the governing bodies. The appointment of an incompetent man because he happens to have influence on the electric lighting committee is the surest way of demoralising the whole undertaking, as the influence of his friends tends to cover up the deficiencies as they arise. We can only trust that the English policy of choosing a capable man, and then trusting him with the whole of the organisation of his department, will always be upheld by our municipalities.

Italian Thunderstorms.—The Roman correspondent of the *Lancet* says that the thunderstorms that have recently visited many of the Italian provinces have done very serious damage to property and occasioned much loss of life. The Ligurian seaboard has suffered exceptionally. "Ball lightning has been witnessed several times, the most dangerous and destructive, fortunately the rarest, form which the 'thunderbolt' is known to assume. Providentially, however, it has this year numbered no victim in Italy. But the ordinary lightning-stroke has caused much loss of life, to say nothing of many grave lesions more or less permanent. Four fatalities are reported from the recent thunderstorm at Genoa, all instantaneous; and at Ventimiglia, in the sacristy of a church, where six priests were assembled, four were killed outright, and the two survivors are in a desperate condition. As a rule, lightning-stroke is most common in the open air, generally under the tree to which the victim has resorted for shelter, and this circumstance, even where only severe injury has been sustained, makes death more likely, as the measures for relieving shock and restoring the vital energies cannot be put in practice till too late. But this year the majority of fatalities from lightning have occurred in dwelling-houses. There is no doubt that for this greater frequency of thunderstorms, as for the more prolonged drought and such like meteorological visitations of latter years, the steady tree-felling, unbalanced by tree-planting, is directly responsible." This account is fully borne out by the reports which have from week to week appeared in *L'Elettricità*, that journal regularly giving a certain amount of space to the subject. It would be interesting to know what authority the *Lancet* correspondent has for considering ball lightning to be particularly fatal. One of the Italian cases happens to have been described in *L'Elettricità*. Two servants were in the room when the "fireball" entered. One ran out, but the other could not. When the ball "exploded" the latter is stated to have sustained a "burn," but was not seriously hurt. The phenomenon is so rare, and the observers are naturally so frightened, that very little is really known about it, and some have even doubted its real existence. Prof. Righi, of Bologna, is stated, by using condensers of great capacity and a large resistance in the circuit, to have succeeded in obtaining a discharge from a Holz machine which would seem to bear the same relation to ball lightning that the ordinary spark does to the "forked" flash. But this is about as far as experiment has gone in the matter, while the theory of the subject is an absolute blank. As to the question of the denudation of the forest land producing thunderstorms, the evidence is very conflicting. The nature of the forest, whether pine, oak, or beech, has probably a great deal to do with it. But obviously in a flat treeless country there will be more fatalities to men and animals than where there are trees or other elevated objects to take the discharge. Consequently a mere counting of accidents is beside the question. Even in classical times Italy was a bad place for thunderstorms.

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THE 1896 MEETING OF THE VERBAND DEUTSCHER ELEKTROTECHNIKER IN BERLIN.

(BY OUR SPECIAL CORRESPONDENT.)

(Continued from page 8.)

The first item of the proceedings on Thursday, the 18th, was a short address from the president of the Verband, Prof. Slaby. This gentleman is to be congratulated on the swing which characterised the whole of the business meetings. The purely business matters had been well ventilated by the organ of the society (*Elektrotechnische Zeitschrift*) previously, and so only the vote of the members was required in most cases. In this way much valuable time was saved for the papers in the programme below.

The great difference between the procedure from that common in England lies in the fact that little or no discussion occurred after the reading of the papers. The tendency of the industry in Germany is for the work, and therefore the technical experience to be gathered together is in the hands of a few large firms. Each of these firms has its own expert in different technical branches of the business, and junior employés are hence debarred from giving their opinions. Much the same thing is sometimes found in England to a smaller extent, but our free-lances in discussions are more numerous. In fact, the discussions here can often justly claim to be more valuable to the profession than the papers which cause them. The arrangements at Berlin by which all the illustrations referred to in the papers were usually handed round to everyone present, is of great service when following the gist of the reading. The secretary's and treasurer's reports were both satisfactory, and show that the society is a power in the land, as can be gathered from my interview with Mr. Kapp. The prize for the best design for a non-interchangeable fuse for different currents was awarded to Mr. A. Rittershausen, of Amsterdam. The rules for given and uniform standards for copper to be used for conductors are as follows :

COPPER STANDARDS OF THE VERBAND DEUTSCHER ELEKTROTECHNIKER.

These were embodied in a committee's report on the subject and passed at the meeting at Berlin on June 18, 1896.

1. The specific resistance of conductivity copper shall be given as the resistance expressed in ohms* of a wire of one metre in length and one square millimetre in sectional area at 15deg. C.

2. The conductivity of copper is the reciprocal of the specific resistance set forth in Paragraph 1.

3. Copper of which the specific resistance is greater than 0·0175, or of which the conductivity is smaller than 57, is not to be considered as conductivity copper.

4. By standard copper of 100 per cent. conductivity shall be meant a copper of which the conductivity amounts to 60.

5. In estimating the specific resistance or the conductivity at other temperatures than 15deg. C., in all cases where the temperature coefficient is not separately determined one of 0·4 per cent. per degree C. shall be allowed.

* One ohm = 1·063 Siemens units.

PROGRAMME.

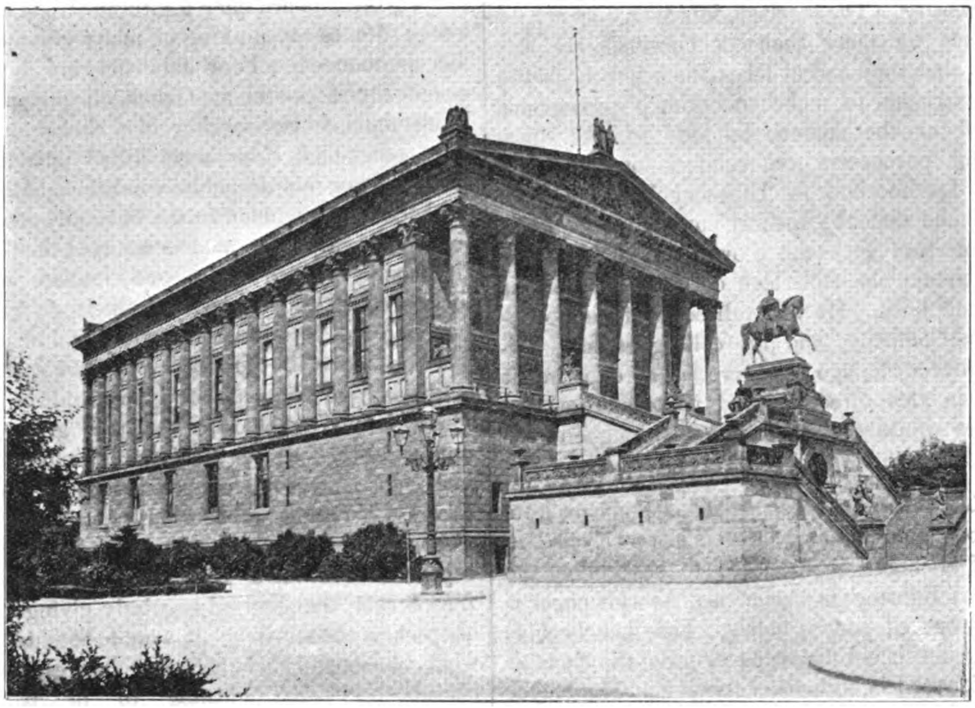
The following is the programme of the business meeting held on Thursday, June 18, at the Architektenhaus :

(1) Presidential address.

(2) Business communications, etc.—(*a*) secretary's report, treasurer's report and estimates, re-election of auditors ; (*b*) reports of committees—(1) on safety rules for electric installations (2) on copper standards, (3) on securing uniformity of contact surfaces and screws, announcement of the award in the non-interchangeable safety fuse competition.

(3) Appointment of new committees.

(4) Papers to be read : (*a*) Director Rathenau, of the Allgemeine Elektricitäts-Gesellschaft, on "The Transmission of Power Works at the Falls of the Rhine" ; (*b*) Director Sarasin on "The Electrical Installation at the Berlin Exhibition" ; (*c*) Dr. Ebeling on "The Magnetic Researches at the Reichsanstalt" ; (*d*) Mr. Bauch on "The Phenomena in the Armature of a Multiphase Motor."



The National Gallery, Berlin.

The business meeting was concluded fairly early so that members could get to the dinner at the Kaiserhof by five o'clock. The organisation of the whole of the Berlin meeting was excellent, but of all the events the palm must be given to the dinner arrangements. The menu was not, as is too often the case, the sole recipient of attention, but the general details of decoration and provisions for the comfort of the guests were most complete. The large dining saloon and ante-chamber of the Kaiserhof were chosen as being the best two rooms obtainable in Berlin. These were handed over to a noted firm of decorators about a week beforehand. Under the personal direction of the committee the decorations were then designed to be in keeping with the history of the electric profession. Names of noted men, suitably framed with electric lamps and surrounded by evergreens, were placed round the walls. Hanging festoons of lamps and evergreens were also largely used both in the dining-room and the ante-chamber. Some idea of the effect may be

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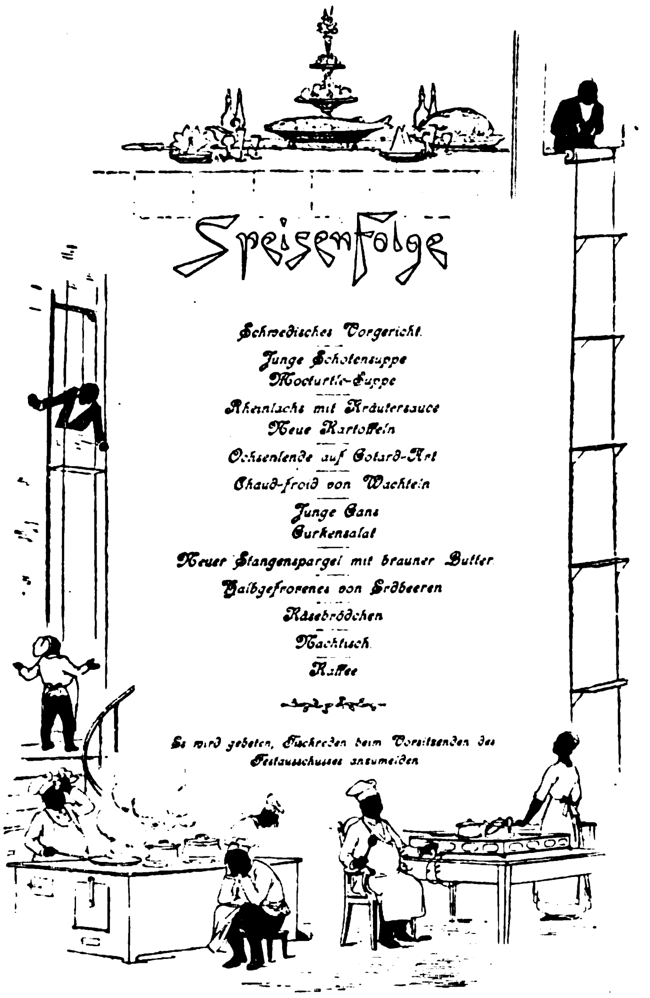
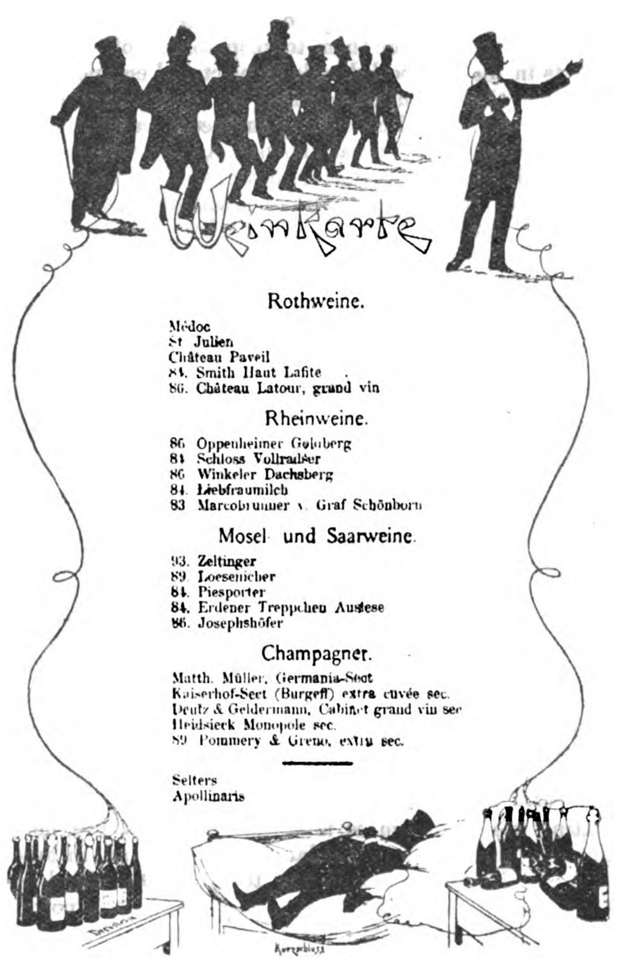
obtained from the statement that over 2,000 incandescent lamps were used in the two rooms; all these were installed specially for the occasion, so that the rooms were lighted in a totally different way to that usually seen by visitors at the hotel. The effect of the lamps, backed everywhere by green foliage, was most pleasing, and, although the rooms were brilliantly lighted, the distribution of light was so good that there was no glare.

Every available corner in the room was banked up with plants and flowers. In amongst the foliage electric fans were placed on pedestals of such a height that a current of air was made to pass just over the heads of the guests as they sat at table. The cooling effect of the fans was increased in some cases by placing blocks of ice near them, so that the air drawn into the fans passed over the ice. Vertical pillars of ice at intervals down the tables helped the cooling effect of the fans.

The floral decorations were throughout most profuse, both on the walls and on the tables. The banks of roses given a place of honour between the latter gentleman and the new president of the Verband, Mr. Stubben, of Cologne. The toasts were interspersed between the courses, and the pleasing custom of clinking glass on these occasions gave many of those present the opportunity of drinking wine with their noted visitor. The speeches were short and witty, so that in no part of the evening did the waiting appear irksome. After the menu, as lengthened out by the toasts, had been completed, coffee was served in the ante-chamber, where, amidst palms and large ferns, a number of picturesque nooks were arranged. This afforded an opportunity for many introductions, and also for the renewal of old acquaintances. Mr. and Mrs. Mark Robinson, who had been attending the Naval Architects' meeting at Berlin, were amongst those present, and agreed with me that the evening's entertainment could be copied with advantage by our English society. We also agreed to lay special stress on the additional pleasure afforded by the presence of ladies at





The Menu and Wine-Card of the Dinner of the Verband.

on the high table were specially attractive. As the ladies are always included in such functions in Germany, the guests harmonised with the surroundings, and the colours of the dresses helped to complete the brilliant scene. Each lady as she entered was presented with a handsome bouquet of roses, the colour of the flowers being appropriately selected. Except at the high table, the placing of the guests was left to their individual selection. I was especially fortunate both in the friends who kindly included me in their group and in the position which we occupied. The two partners of the noted publishing firm of Julius Springer and Co. were practically my hosts for the evening, and my enjoyment was due to their kind attention. The guest of the evening was the Viceroy of China (Li Hung Chang), in whose honour a number of Chinese flags were displayed. The Chinese royal standard, a gorgeous production in yellow and black, was hung behind the chair of the distinguished statesman. The son of the viceroy (Lord Li) was also present, and I was pleased to note that Mrs. Kapp was such functions. The band of the Second Regiment of the Guards played in an annexe to the ante-chamber. The two large rooms were connected by a series of lofty arches. The music, although always audible, was not too loud at any part of the large dining-room. One noticeable coincidence in the musical programme was that Li Hung Chang left the room while the "Mikado" was being played by the band.

The menu, with the music programme and wine card attached, gave the committee another opportunity of showing taste in small details. I give with this a reproduction on a smaller scale of the menu and wine card. The illustrations on them need no description, except, perhaps, to state for the benefit of some readers that the word under the reclining gentleman on the wine card means "short-circuit."

Interview with Mr. Gisbert Kapp on the Work of the Verband Deutscher Elektrotechniker.

I found Mr. Gisbert Kapp, the energetic secretary of the

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Verband, most ready to give me introduction to the leading engineers in the society during the meetings. His time was, however, so taken up with the business in hand that an interview was impossible till the following week. A great deal of the work accomplished by the society can be gathered from the programme of the business meetings, but Mr. Kapp kindly consented to give me further details for the benefit of the *Electrical Engineer* readers.

The object for which the Verband was founded was to unite the whole of the electrical engineers in Germany for the common good of the industry and also for mutual protection. In carrying out these objects the society has also served as a protection to the public, and has had to considerably widen its original programme. Thus, it is now often called upon to give unbiassed reports on technical matters to Government departments and to municipal bodies. Mr. Kapp explained that the state of the consulting engineering profession in Germany was entirely different from that in England. The consulting engineers consist, firstly, of a few high-school professors, who are wholly unbiassed in their advice and who also have great scientific knowledge. Their arduous duties in teaching and in original research, however, take up so much of their time that it is hardly possible for them to keep abreast of the improvements in the practical details of electrical engineering.

After these gentlemen may be mentioned the small number of practical consulting engineers in Germany who, in experience and general knowledge, rank with our leading men in England. They have, however, added a contracting element to their business, now practically extinct in our country. An engineer of this class, when called in to prepare a scheme for electric lighting or power transmission, will not only advise as to the best system and the cost of installing it, but also guarantees that the work can be done for the figure named. If his plans are accepted, he then proceeds to carry out the work himself and to order the necessary machinery personally. This arrangement is apt to lead to the consulting engineer becoming more or less a contractor.

Mr. Kapp then explained to me the usual course adopted by a German town when they require an electric light installation. The town authorities fix the magnitude of the installation they require, and then invite several of the large firms to give them designs and estimates. The tenders sent in of course will differ widely both as regards the system of distribution and the type of plant to be used in the power station. Also, the cheapest tender may in the long run be the least advantageous to the town authorities, on account of the greatest cost of production entailed by its use. In such a case the Verband Deutscher Elektrotechniker is an independent authority to which such schemes may be submitted. Mr. Kapp is usually the adjudicator, but by the rules of the society his advice must only consist in stating which system is most advantageous, and he must not recommend any particular tender. As an instance of this, Mr. Kapp mentioned the town of Dortmund, where they required electric light, and also electric power for driving the cranes at the harbour. The schemes sent in in this case varied very largely. One firm proposed separate power stations, one for each purpose; others proposed three-phase and others direct currents. An independent engineer was therefore necessary to settle the difficulty. Again the advantage of being able to draw information from any member of the Verband gives Mr. Kapp in such cases great advantage in coming to a decision.

In certain great questions of national economy it has become the custom of the country's Ministers of State to consult the Verband. An instance of this occurred at Memel. Here the River Russ forms a delta of very rich soil, which is, however, under water for half the year, and hence useless. As the country round is a most valuable one to the Government for horse-breeding purposes, the inspecting engineer of the district was instructed to investigate the best means for draining this land. He found from experience in the neighbouring districts that the cost of working individual pumps by steam-engines was excessive, owing to the quantity of coal used. He then conceived the idea of using the very best modern steam-engines and of saving the labour expenses of attendance at individual stations by using electrical distribution of power. He submitted his scheme to the Government, who commanded Mr. Kapp to proceed to the spot and investigate the matter. In this case Mr. Kapp reported that the electric distribution of the power would save a considerable sum per annum. The system he advised was a three-phase one at 5,000 volts, and he also pointed out the great advantage of being able to let electric power to the farmers in the summer, when the pumps need not be worked. The electric light would also be of great service when storms damaged the main dyke in winter, as repairs then have to be carried out night and day.

The Verband is also largely concerned in providing for the public safety. It has drafted fire rules, which are universally accepted all over the country. These rules were most carefully drawn up by a committee consisting of representives from every electrical society in the empire, and hence are accepted by all. Over 5,000 copies of these rules have now been bought and circulated, and will tend to that uniformity of practice in installation work so much to be desired. The society has now before it some rules for regulating high-tension systems, and in the consideration thereof will derive great assistance from its Bavarian members, who have had large experience in high-tension work. As an example of the trust the public has in this society, Mr. Kapp told me that the Mayor of Essen, in whose town a 3,000-volt three-phase system was to be installed, asked the Verband to specify the conditions which must be fulfilled to insure the public safety.

MR. GISBERT KAPP, M.I.C.E., M.I.E.E.,
Secretary of the Verband Deutscher Elektrotechniker.

The question of a uniform standard for comparing the conductivity of copper for conductors has also been decided during the past year. The rules prescribed for this purpose I am able to give in full below.

Mr. Kapp then took up the question of the making of laws concerning the electric lighting industry. It seems that the German Government are contemplating the passing of a law making the calibration of electric light meters by an independent authority compulsory. They have asked the Verband to nominate experts to assist the Government to frame this law in a fair and equitable manner.

The last, but not the least, of the objects of the society is that of promoting intercourse both socially and professionally amongst its members. This is being done by the annual meeting which I have had the pleasure of attending. At it papers on subjects of scientific and commercial interest are read and discussed to the mutual advantage of rival firms. Also the social gatherings tend to bring the whole of the leading members of the profession together, and to tone down the discordant spirit engendered by keen business competition. The belief in the good effected by these annual meetings is shown by the generous way in which the Berlin gathering has been supplied with funds. The expenditure in this case has exceeded the income from the sale of the tickets by over £1,000, which

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sum was largely provided for beforehand by the Berlin banks, who benefit largely by an increase in the prosperity of the industry. The leading electrical firms in Berlin also subscribed handsomely, and the Verband subscribed the rest. The co-operation in this way of rival interests cannot but have a powerful influence for the general welfare.

Interview with Mr. Frederick Drexler on the Recording of Alternate-Current Wave-Forms.

In an interval between the two portions of the programme on the Saturday I had a conversation with Mr. Drexler, who represents the Oerlikon Company at Vienna, about the method he has devised for recording the wave-forms on alternate current systems. Mr. Drexler's object has been to design an apparatus which shall be available for recording the shape of the waves on a commercial electric light system. He explained to me that most of the methods already devised take some considerable time to obtain the correct wave-form. As a rule individual points on the curve are obtained with accuracy, but by the time the points required to complete the wave have been observed the conditions are likely to have altered, unless precautions which can be only used in a laboratory are adopted. Hence, although these methods are extremely good for research work, they are hardly suitable for use on the mains of an electric light station.

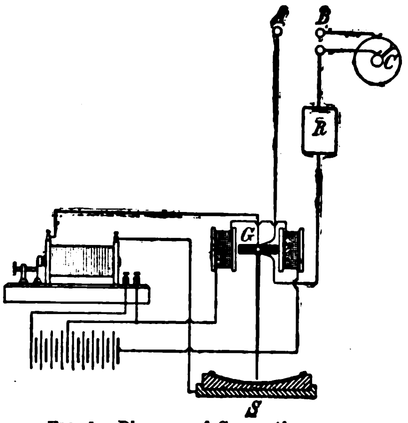

FIG. 1.—Diagram of Connections.

Mr. Drexler's scheme permits of the complete record of the wave-form being taken in under two seconds. The apparatus used is shown diagrammatically in Fig. 1. An electric motor is used, which may be either a direct-current one or a non-synchronous alternate-current motor. The speed of this motor must very nearly coincide with the speed corresponding to the frequency of the system, but it must not quite coincide. On the shaft of this motor is placed an insulated disc having one point of contact on its circumference. The connections between the alternate-current supply and the galvanometer is then completed at intervals by the two brushes shown in the diagram. One of these brushes rests on the spindle of the motor and the other on the insulated disc. The connection is thus made when the conducting point, C, on the disc passes under the brush. If the speed of the motor exactly coincides with that of the frequency of the system, the circuit would always be completed at the same point on the wave-curve.

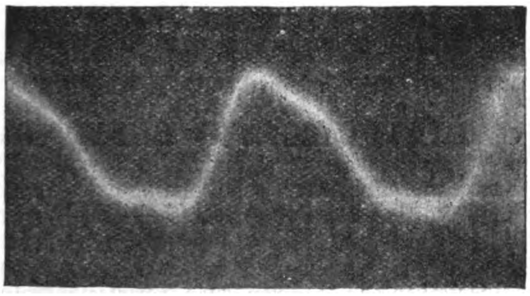

FIG. 2.

The rest of the circuit consists of an adjustable resistance and a Deprez galvanometer, G. The field of this galvanometer is excited by a small battery, and the moving coil is in circuit with the contact-maker described above. The needle, or pointer, of this galvanometer gives a deflection proportional to the voltage applied to it, which varies with the point on the wave at which the contact is made. The effect of the inertia of the moving parts of the galvanometer can be reduced to a minimum by making the difference between the speed of the motor and the natural period of the circuit small. The rate of change of the voltage is then small, and hence, as Mr. Drexler explained to me, the needle of the galvanometer can be relied on to give a correct value. The recording arrangement used by Mr. Drexler in obtaining the curves herewith is also shown diagrammatically in Fig. 1. A sensitised film on celluloid is fixed in a holder of radial cross-section, the radius being slightly more than that described by the end of the galvanometer pointer. The holder has a metallic backing, and a silent discharge from a Ruhmkorff coil is made to pass from the needle through the sensitised plate to this holder. The silver salts on the film are thus decomposed. The film is driven forward by clockwork, so that the discharge traces out on it the form of the alternate-current wave. The three illustrations, which I am able to give by the courtesy of the proprietors of the *Elektrotechnische Zeitschrift*, were all taken on the supply from the Vienna electric light station to Mr. Drexler's private house. They show how greatly the wave-form varies under different conditions of load, and the importance of using a method like the one described, in which the record is obtained in a few seconds. The motor used in the test was a small non-synchronous fan motor. Although a smaller difference in speed could be obtained if a direct-current motor is used, the alternate-current motor has the advantage of automatically following slight alteration in frequency. I understand that Mr. Drexler is arranging the apparatus in a portable form for conveniently testing the wave-forms at any point on the mains. In this case a slightly different form of recorder will be used, as with the present apparatus the test has to be carried out in a dark room. The present form of recorder gives a rather broad outline to the curve, but the breadth is exaggerated by the reproduction. Other methods of tracing the wave shape can, however, easily be devised.

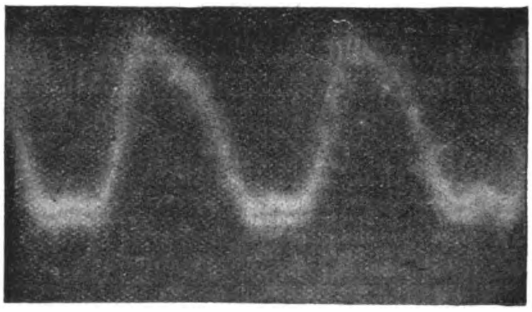

FIG. 3.

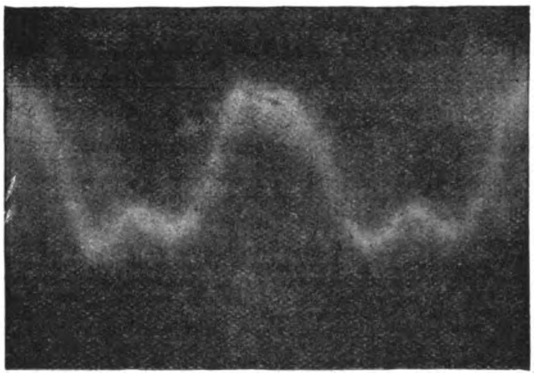

FIG. 4.

(To be continued.)

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RAILWAY BLOCK SIGNALLING.

BY J. PIGG.

(Continued from page 10.)

Roughly, instruments for block working may be placed in one of two divisions. In the first, the indicating apparatus is stable in either of the positions it can take up, the current is transient, and is only used to effect a *change* of position. In the other division, the indicating apparatus is stable in one position only, and change of position from the normal can only be *maintained* by a continuous current.

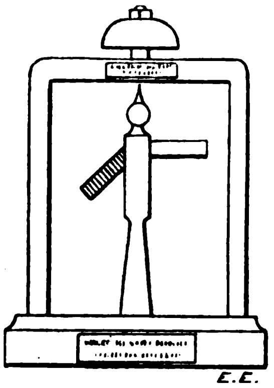

FIG. 3.—Walker's Block Indicator, One Wire.

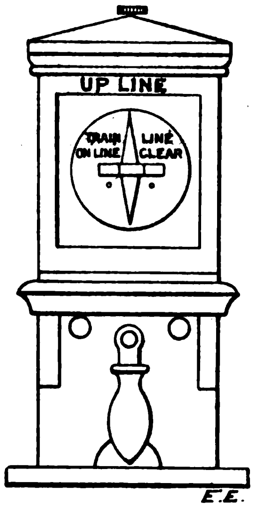

FIG. 4.—Single-Needle Block Indicator, Three Wires.

An example of instruments of the first division may be seen in the block instrument invented by the late C. V. Walker (Fig. 3), which was at one time in general use on the old Stockton and Darlington Railway, now a division of the North-Eastern Railway, and is still to a limited extent. This instrument was also in use on the South-Eastern Railway, of which Mr. Walker was at one time the electrical engineer. A further example of this class of instrument, but of different construction, is the one-wire needle instrument of Tyers (Fig. 5) now in use on the L. and N.W. Railway.

Examples of instruments of the second division are furnished by the single-needle three-wire block instruments in use on the North-Eastern, Great Northern, Midland, L. and N.W., and other railways (Fig. 4).

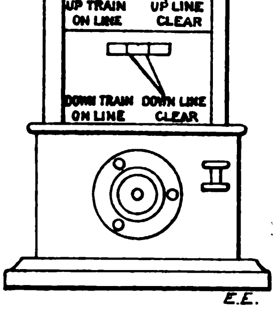

FIG. 5.—Tyer's Block Indicator, One Wire.

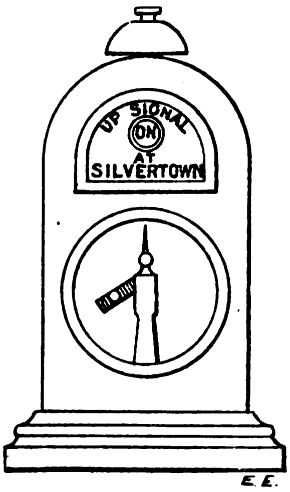

FIG. 6.—Preece's Block Indicator, One Wire.

Instruments of the first division indicate two conditions of the line only—viz., "Line clear" and "Line blocked," or "Train on line." Instruments of the second division indicate three conditions of the line—viz., "Line blocked" (the normal position), "Line clear," and "Train on line." The difference just shown may seem to be of minor consequence, but it is, in reality, of the first importance to the proper indication of the exact position of affairs at any stage of block working. "Line clear," with instruments of the first division, indicates that there is no train in the section of line to which the instrument refers. With instruments of the second division, however, it not only indicates that there is no train in the section, but also that the signalman at the receiving end *has given permission* for a train to be sent forward, and *has made* preparations for its arrival.

As an illustration of the difference in working with the different classes of instruments, the following extracts from the regulations setting forth the methods of working are given:

"Prior to the despatch of a train from A, the signalman there, provided he has received the 'Train out of section' signal for the previous train, and the block indicator is in its normal position, must call the attention of B, and having obtained it, must give the proper 'Is line clear' signal; if the line be clear at B, the signalman there *must acknowledge the signal by repeating it.* The signalman at A may then, if the line is clear, take off his signals for the train to leave A.

"On the train leaving A, the signalman there must send the 'Train entering section' signal to B, and the signalman at B must acknowledge the signal by placing the block indicator to 'Train on line.'"

"Prior to the despatch of a train . . . from A, the signalman there, provided he has received the 'Train out of section' signal for the previous train, and the block indicator be in its normal position, must call the attention of B, and, having obtained it, must give the proper 'Is line clear' signal; if the line be clear at B, the signalman there *must acknowledge the signal and peg the block indicator to the*

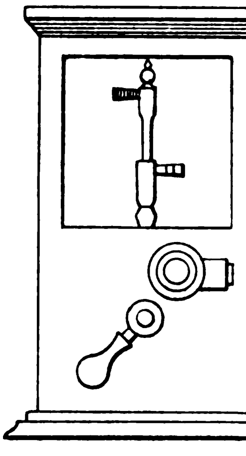

FIG. 7.—Hodgson's Block Indicator (Saxby and Farmer's Lock and Block), One Wire.

'Line clear position.' The signalman at A may then, if the line is clear, take off his signals for the train to leave A. On the train leaving A the signalman there must send the 'Train entering section' signal to B, and the signalman at B must acknowledge the signal and peg the block indicator to 'Train on line.'"

The first of these quotations represents the mode of working a single-wire system with instruments of the first division. In this case the signalman at the sending end has nothing to remind him that he has or has not obtained permission to send a train forward to the advance cabin, and the signalman at the receiving end has nothing to remind him that he has given or not given such permission. In both cases the signalmen have to rely on their memories or their booking for reminders of the "Is line clear" signals that have passed between them.

The second quotation is for a three-wire system, with indicating instruments of the second division. In this case the "Is line clear" signal and its acceptance by the signalman at the advance cabin is recorded at both ends of the section until the permission has been acted upon, and the "Line clear" indication is superseded by "Train on line."

With either class of instrument the line is considered "blocked" until permission is given by acknowledging, by repetition, the "Is line clear" bell signal, but the fundamental difference between the two modes of working is the ability, with instruments of the second division, to record the acceptance of the "Is line clear" signal, so that the

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signalmen at both ends can, from the indications of their respective instruments, obtain reminders of the signals that have passed and the position of the line at any time. Obviously, the condition of a section cannot be the same after permission has been given to forward a train as before that permission was given, even if the train has not actually entered the section. The acceptance of the preliminary "Is line clear" signal indicates that the line is clear to the advance cabin, that previous trains are fully protected by signals, and that no operations involving the fouling of the line will be undertaken at the advance cabin until the train accepted is clear. Hence, it would appear that instruments of the first division fail to take cognisance of what is without doubt an important condition of the line. How important it is that the operations of the two signalmen, who must necessarily co-operate in the working of traffic, should be perfectly synchronised need not further be commented upon.

Generally, it may be said that instruments which require only one line wire for all the operations involved in double-line block working are those which use transient currents only, whether employed as train-distinguishing signals or as indicators, since the line may be required for the former signals whilst the instruments are indicating "Train on line" for one or other of the lines of rails for which it is used. Conversely, it may be said that instruments which require continuous currents for the maintenance of their

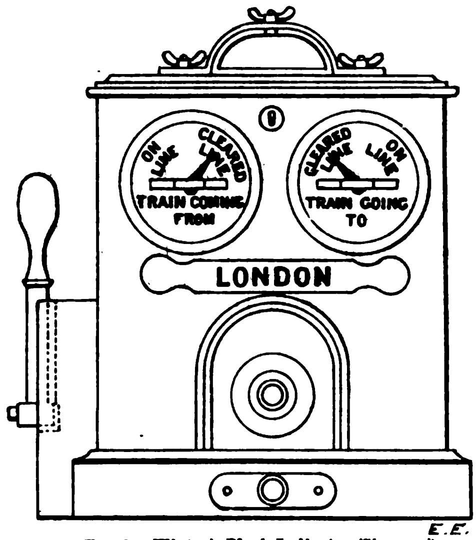

FIG. 8.—Winter's Block Indicator (Siemens').

indications are those which will require three wires, since the indicators must work independently of each other and of the bell signalling apparatus.

From what has been said it follows that the number of independent batteries required will be less for instruments of the first division than for those of the second division, since under actual conditions of work currents are not likely to be used in any one cabin in both directions simultaneously. Where transient currents are used only, the number of batteries required may be reduced to the number of operations that may be carried on simultaneously. With instruments using continuous currents for maintaining the necessary indications, the number of independent batteries required will necessarily be greater owing to the greater number of operations which may require to be carried on at the same time.

It would therefore appear that block instruments using transient currents, and requiring not only one line wire but a smaller number of independent batteries, would be preferable considered from an economical standpoint. Against this advantage it is urged that cutting down the line wire to one, and reducing the battery power to an absolute minimum, is an operation of the nature of putting too many eggs in one basket. If a fault occurs on the line wire, both lines of rails are affected, and must be worked at "Caution" until the defect is removed. If the telegraph lineman is not immediately available, the disorganisation of traffic may be considerable.

On the other hand, with instruments of the second division, a failure of one line wire affects that instrument and the line it represents alone, the other line being worked as usual. It by no means follows that the number of line faults on a three-wire block will be three times that on a one wire.

An important point in connection with the class of instrument most suitable for block working is the indication the apparatus will give when, through a defect, the instruments are not available for use. With instruments of the first division the indication will remain in the position it happened to occupy at the time the defect occurred. This may be either "Line clear" or "Line blocked," according to the condition of the line at the time. With instruments of the second division, where any indication other than "Line blocked" is only maintained by the use of a continuous current, a defect of the line wire or battery will at once cause the indicators to show "Line blocked."

When a defect arises in the block apparatus for any section, involving the suspension of block working, the ordinary space limit is replaced by a time limit, and every train which is sent through that section must be first brought to a stand and the officials in charge of the train advised of the breakdown and instructed to proceed cautiously. Practically, the section of the line where the failure exists is treated as if blocked on the *approach* of any train which may require to pass through that section. With instruments of the first division the indications of the faulty block instruments may, or may not, correspond with the theoretical condition of the line; with instruments of the second division, the defect ensures the indications being such as will correspond with the conditions under which the line is being worked. Instruments of this class may therefore be fairly considered as more reliable under the conditions cited than those of the first division, and the indicators have the further advantage of being self-testing to a large extent when in use.

(To be continued.)

CITY AND GUILDS OF LONDON INSTITUTE.

LECTURE XXXII.

(Specially Contributed.)

Magnetos for Bell-Ringing.—Batteries may with advantage be replaced by magnetos whenever the signalling circuit has a high resistance. The latter cost little for maintenance or inspection. There are no troublesome fumes nor dangerous acids to work with, though the initial cost is greater. When batteries are used with high-resistance circuits, the current from the primary battery is often too feeble to work the apparatus, and a

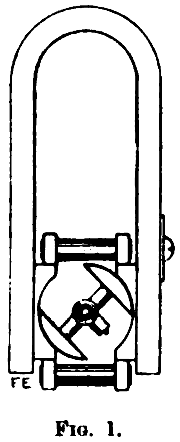

FIG. 1.

supplementary piece of apparatus—the relay—is brought into the circuit. This is merely a means to enable the current of the first battery to close the circuit of a second battery, and to enable the current from the second battery to actuate the required apparatus. The use of a magneto usually avoids the necessity for a relay. These several advantages have led to the almost universal adoption of magnetos for telephonic work, and it is in this connection I shall give a brief description of the apparatus. The particular apparatus

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described is manufactured by the Western Electric Company. It is known as the bridging bell, and has been designed to permit of several instruments being connected in parallel on the same line. It is necessary to say this because other manufacturers modify the design. The armature of the magneto is of the Siemens shuttle-wound type, as shown in section (Fig. 1).

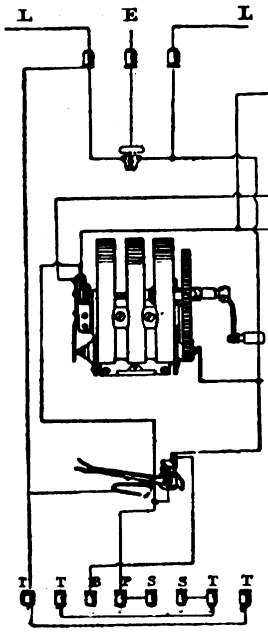

FIG. 2.

The field magnets are three strong permanent magnets of horseshoe type. The armature is revolved by means of a toothed wheel of large diameter engaging a toothed wheel of smaller diameter, as shown in Fig. 2. The magneto, or, as it is usually called, the generator, will ring its own bell through a resistance of 15,000 ohms. A little consideration will show that in an ordinary telephonic circuit there must be instruments—say, bells—at the receiving and at the sending ends, and the coils of both armatures would in the simplest form of circuit be in the circuit, in addition to the coils of the electromagnets attached to the bell. Thus, besides the line wire connections, we have the two armature coils and the two electromagnet coils, the whole giving a very high resistance. In

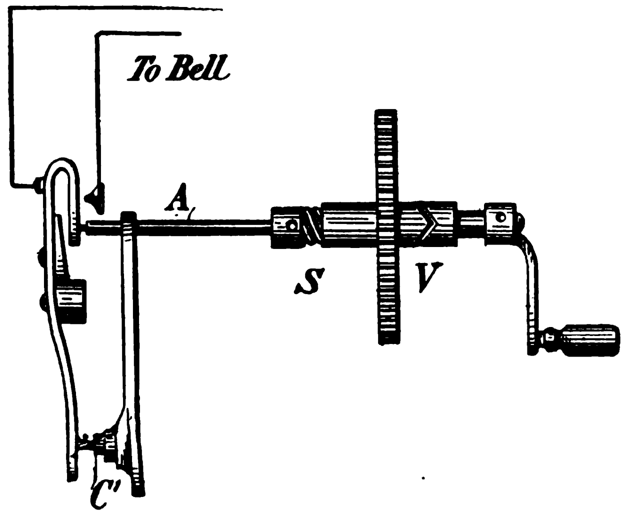

FIG. 2A.

order to decrease this line resistance, as we may call it, efforts have been successfully made to cut out the resistance of the armature coils when receiving, leaving in the line circuit the armature coils only of the sending instrument, and when sending to cut out the coils of the sender's bell. Very ingenious are the various automatic switching arrangements for this purpose. The switch used with the apparatus (Fig. 2) is known as the Chicago switch. Fig. 2A shows more clearly the action of this switch, C_1 showing end of armature spindle. The contacts are made of platinum to avoid oxidation, and are rubbing contacts for cleanliness, and have strong springs to ensure good contact. The driving spindle of the generator, by means of a V working in a slot at the right-hand side (Fig. 2), has a straight movement to the right when the handle is turned, and this motion actuates the automatic cut-out at the left of the generator. When the generator is at rest, the bell coils are in circuit to receive any signals from other stations while the armature coils are cut out, thus saving about 500 ohms—the resistance of the armature coils—in the working circuit. When the handle of the generator is turned, the armature is in direct connection with the line, and the instrument bell is short-circuited, saving a resistance of 1,000 ohms, which is the resistance of the bell coils. The external connections of magneto shown in the figure are: L L, lines; E, earth; A B, auxiliary bell, which is also of 1,000 ohms resistance; T T, receivers; B, one pole of transmitter battery, the other being connected direct to primary of induction coil; P, other end of primary

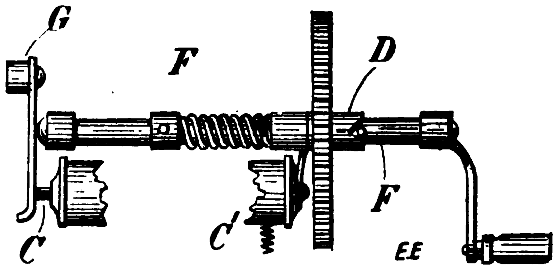

FIG. 3.

coil; S S, secondary winding of induction coil. This instrument will efficiently work up to 10 instruments in parallel. Fig. 3 shows an old form of cut-out. C C_1 show connections to armature, C to a contact-piece, C_1 to spindle, D is the notched hub of wheel; there is a pin gearing into the notch D, while F is a collar on the

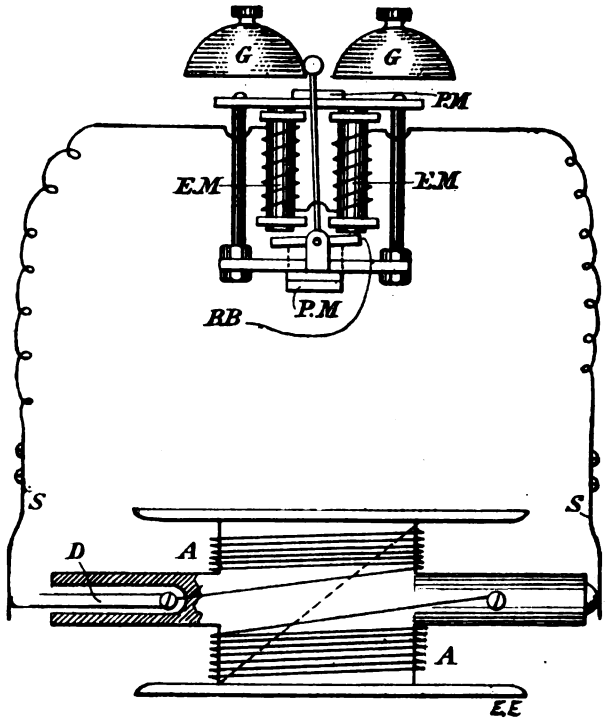

FIG. 4.

spindle holding one end of spring, as shown. This spring holds the pin against one end of slot, making a good contact between the spindle and spring G, short-circuiting the armature coil, which is connected to the spring G and the wheel. When the handle is turned the pin is moved forward to the other end of the slot, moving the spindle to the right hand, and as long as the handle is turned the spindle is held in that position, breaking the short-circuit, and putting the armature coil into the working

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circuit. Fig. 4 is a rough sketch showing the connections between magneto armature and bell. Here A A represent armature coils; S S, spring contacts carrying current to line wire and return; E M, E M, the bell electromagnet; P M, P M, the ends of the bell permanent magnet; B B, the soft-iron armature; G G, the bell gongs. There are two gongs, because the current being alternate causes the attraction of first one and then the other half of the soft-iron armature, B B, and first one, then the other, of the gongs is struck. A permanent magnet, P M (Fig. 4), and shown in section (Fig. 5), is used in these bells, the lines of force acting

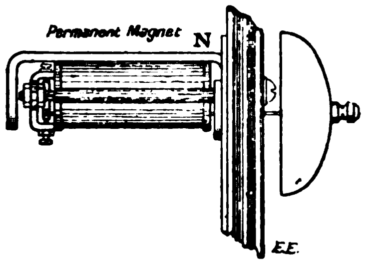

FIG. 5.

on the cores of the electromagnet, and so arranged that a bias is given to the soft-iron armature towards one pole of the electromagnet, and hence to the striker towards one of the gongs. The efficient action of the bell depends largely on the adjustment made by the use of this permanent magnet. As I have previously said, with the exception of their use in telephonic work for the bell signalling circuits, magnetos have practically gone out of use and given place to dynamos, and these we must now examine at some length.

JOHNSON AND STEELE AUTOMATIC POTENTIAL ARRESTER.

The instrument illustrated below (Fig. 1) is the invention of Mr. L. J. Steele. It is practically a lightning arrester, to be used for comparatively small potentials, such as are likely to be found when the shunt circuit of a dynamo is broken. The device consists of two carbon discs mounted side by side on a slate base. These discs are pressed towards each other by springs, but between them is interposed a strip of mica, which, not being so wide as the faces of the discs, leaves a small air-space between them. The air-gap thus secured can be regulated by varying the thickness of the mica, so that the potential at which the spark will pass between the two discs may have any predetermined value.

A safety fuse is placed in series with the arrester, as shown in Fig. 2, which, in case of a permanent circuit being established between the discs, will give way, and thus prevent short-circuiting the field coil, when the current is afterwards switched on again. The discs can be turned on their axes, so as to present towards each other fresh portions of their peripheries after a spark has passed.

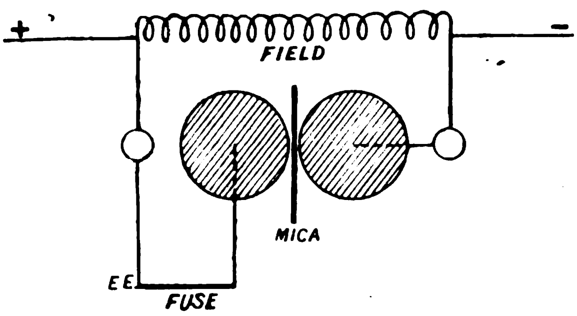

FIG. 2.—Connections for Potential Arrester.

Metal scrapers are also provided (Fig. 1) that bear against the edges of the discs, and clean them as the discs revolve.

The great use of this device is for preventing the rise of pressure on breaking the exciting circuit of dynamos and alternators from injuring the insulation of the field coils. A simple calculation will show how great this potential may be, and it is no uncommon occurrence for a shunt coil to be connected to the frame by the discharge. With the above device the spark-gap between the carbon plates takes the discharge, the connections used being those shown in Fig. 2. The spark at the disc persists till the field has died away. This, in some cases, takes some considerable time. Thus, when breaking the field circuit of large multipolar machines or alternators, the spark is seen to last as long as 20 to 30 seconds.

The apparatus is manufactured by Messrs. Johnson and Phillips, who have supplied a large number of sets, which have, we believe, given every satisfaction.

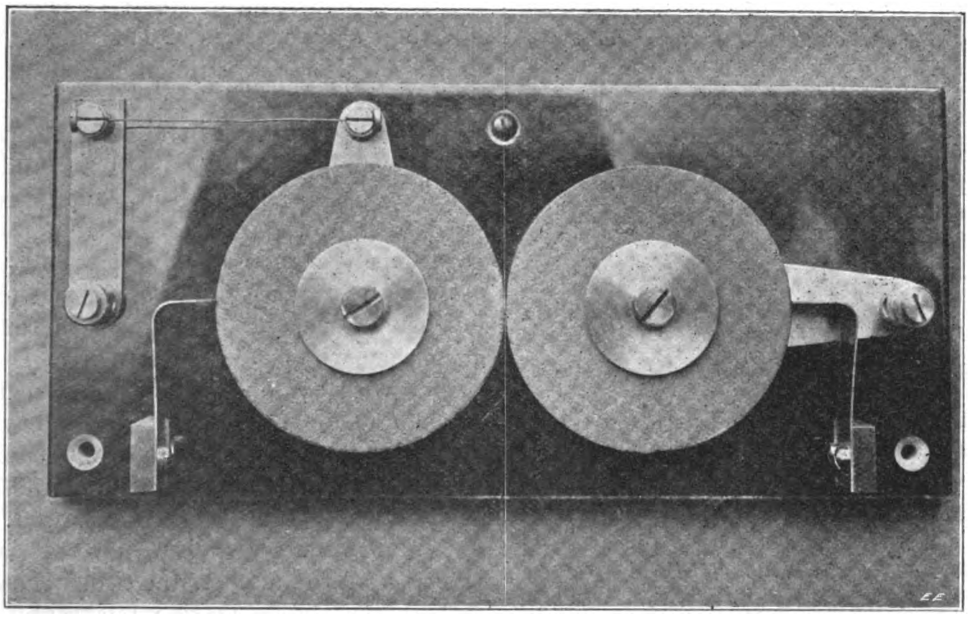

FIG. 1.—View of Johnson and Steele's Potential Arrester.

Royal Institution.—At a general monthly meeting of the members of the Royal Institution on the 6th inst., Sir James Crichton-Browne, M.D., LL.D., F.R.S., treasurer and vice-president, presiding, the Right Hon. Lord Windsor, Mr. Herbert Page, F.R.C.S., and Mr. Alfred Suart were elected members.

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THIRTY YEARS OF CABLE WORK.

Sir John Pender is dead. Thirty years ago this very month England and America were on the tiptoe of expectation. Attempts had been previously made to connect these opposite Atlantic shores by means of a submarine cable. These experiments had been eminently successful failures. We use these words advisedly, because the failures taught the way to success; and it was in July, 1866, that the first Atlantic cable was laid that did not break down directly. Subsequent to the successful laying of the 1866 cable, the 1865 cable was picked up and repaired, since when the Old and the New Worlds have never ceased to be in telegraphic communication. Thirty years is not a long period in the pages of history, but during the past thirty years the world has been so connected by cable links that almost instant communication with the Antipodes has ceased to excite surprise. The veriest street *gamin* looks upon it as a matter of course, presenting nothing extraordinary to his mind, being merely an incident in daily life just as eating and drinking. In 1858 the first attempt was made to connect telegraphically Europe with America. The cable manufactured for this experiment had for conductor a copper strand consisting of seven wires (six around one) and weighing 107lb. per nautical mile, the insulation consisted of guttapercha laid on in three concentric coatings and weighing 261lb. per nautical mile, the whole being protected with eighteen strands of iron wire (each of these eighteen strands consisting of seven wires) laid spirally round the core with a padding of tarred hemp between the core and the protector. The weight of the cable in air was 20cwt. per knot, and in water 13·4cwt. The length of cable shipped was 2,174 knots. As we all know, the 1858 experiment ended in failure, and then came the tug-of-war. It was comparatively easy to obtain funds in the first place. Shorter cables were doing good work, and everybody hoped for success with the Atlantic cable. Cyrus Field took up the matter, and impressed his views upon business men in America and in England. It was an arduous task, but in the long run was destined to succeed. Here and there he met with enthusiasts who gave their support. Here and there he met with long-headed business men who could see money in the undertaking and who felt convinced that if a mile of cable could be made to work, so could ten, one hundred, or a thousand miles. And they were right. The late Sir John Pender was one of the business men who took up the matter, and from these early days in the history of submarine telegraphy to the time of his final illness he was a prominent figure in all that concerned cable work, and, with his friends, controlled a large part of the cable network of the world. But to go back. We have given a brief specification of the 1858 unsuccessful cable—we may therefore venture to give a similar account of the successful 1866 cable, which, again, was very similar to the 1865 cable, which in 1865 was lost and in 1866 was found and spliced. The conductor of the 1866 and 1865 cables was a copper strand of seven

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wires, weighing 300lb. per knot, embedded in Chatterton's compound; the insulator was four coatings of guttapercha interlaid with four of Chatterton's compound. The protector of the 1866 cable differed somewhat from that of the 1865. It consisted of ten wires of homogeneous iron, each wire first galvanised and then bound with five strands of white Manilla yarn, the ten wires wound spirally round the core with an intermediate padding of saturated hemp. The weight of the cable in air was 31cwt. per knot, in water 14·75cwt. It had a breaking strain of 8 tons 2cwt., and would bear its own weight in twelve miles depth of water. The length shipped to lay the 1866 cable and splice the 1865 cable was 2,730 knots. It was on Sunday, July 1, 1866, that the "Great Eastern" left the Nore. The shore end was laid from the "William Corry," and on July 13 the "Great Eastern" began her work, and on the morning of the 27th sighted "Hearts Content." On the 28th the shore-end splice was finished, and the New World was in electric connection with the Old. The first message after testing was to Lord Stanley, the Foreign Secretary, and the Queen from Osborne sent a congratulatory message to President Johnson. On August 1 began what may be termed the real working life of the cable—that is, it was opened for the transmission of ordinary business messages. Just one more reference to the 1865 cable. After considerable trouble and anxiety it was grappled, and on Sunday, September 2, 1866, the end was on board, and the tests showed conduction and insulation all right. The new piece was spliced to the submerged cable, and the "Great Eastern" headed once more for Newfoundland, which was duly reached on September 8, a splice made with the shore end, and two cables at work. As we have said, the late Sir John Pender took an active part in all the financial and business proceedings in connection with this work, and devoted the last thirty years of his life to the development of submarine telegraphy. It needs but a few thoughtful minutes to realise what submarine telegraphy has done for the world. It has in a measure annihilated time and space. It has made commercial transactions easier, and one of its most far-reaching properties has been to practically double the value of capital. Many financiers and statisticians talk learnedly about the appreciation of gold, but they seldom discuss the causes which have led to the appreciation, not the least of which has been the extraordinary development of submarine telegraphy.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

ELECTRIC DRIVING POWER.

[For some years we have contended that electrical manufacturing firms ought to do a very large business in arranging motors for printing offices. We are glad to see some correspondence on this subject in one of the trade papers devoted to the printing industry, the *British and Colonial Printer and Stationer*, and no doubt a little concerted enterprise between supply stations and manufacturers ought to enable a good footing to be established in this direction. We give the correspondence herewith.—Ed. *E. E.*]

Sir,—I read with much interest your remarks on the application of electricity to the driving of printing machinery. Many years ago I came to the conclusion that to drive from shafting was a great mistake. Against the advice of the makers of a new rotary web-printing machine I had a direct-acting engine made for it. Driving direct in that case convinced me that it was the right thing, and I have since had all our machines driven by separate engines. The result is that they can be worked to much better advantage, and with a great deal less waste. I have now had several electric motors introduced. One drives a small flat machine, and as the machine is only used at intervals for a few hours a day, I find electricity in its case very handy, and not very expensive. For steadiness electricity beats steam and gas, and there is no trouble whatever in starting or stopping at any moment, as the power is always at command. I have electric motors driving an installation of 10 Linotype machines, and find that although the cost may be a little more there is full compensation in being able to get the machines to work at any moment in case of emergency. The great drawback to the general introduction of electricity is the expense of turning out already existing plant which does the work, although in a more clumsy way. For anyone going in for extension or new premises and plant it would be, in my opinion, sheer foolishness not to adopt the electric motor.—Yours, etc., Scotus.

Edinburgh, June 27th, 1896.

Sir,—I have read your "London Letter" in your issue of the 25th inst., on "A New Adaptation of the Electric Motor," with much interest, and with a view to further ventilating the subject have pleasure in giving you particulars of our installation.

The question as to the best means of transmitting power to machinery placed in various but adjoining buildings arose when we (Bemrose and Sons, Limited) decided to build an extensive addition to our works, comprising some 14 large rooms in all, and after thoroughly investigating the matter, we decided on motors as being the most suitable; economy, convenience, cleanliness, and, we expect, durability, being amongst the advantages.

The result of this decision being that we ordered a complete installation of two dynamos of about 100 h.p. each—already having one of about 40 h.p.—and some eight to ten motors as a start. We have now the first motor actually at work—driving four printing machines (two quad demys and two double royals)—and we are exceedingly pleased with the result. After careful consideration we decided to group our machines, of four or six to a motor, and this is where our system differs from that suggested in your article—in the latter case you certainly do away with some friction on shafting and belts, especially when all the machines in the group are not working, but the saving is infinitesimal, as I think it will be found advisable, even if not absolutely necessary, to have each motor connected by a countershaft and belts (even if driving a single machine), as even low-speed motors are much too fast for direct coupling; and it should be borne in mind that the slower the motor's speed, the larger and more expensive it becomes, and consequently more difficult for convenient direct attachment. Now, on the group principle there is the same saving of power, as the motor only consumes the actual amount of E.M.F. required to do the work placed upon it, and this is proportionate to the number and size of machines actually running; further, we were advised that a greater efficiency is obtained from, say, a 6-h.p. to 10-h.p. motor than from a 1-h.p. to 2-h.p. one, and there is less proportionate expense in the wiring, switches, etc., apart from the saving in the initial cost of the motors.

We expect to derive considerable advantage, seeing that it is so handy to place motors either in the basement or fourth or intermediate floors, and that future extensions in machinery can be dealt with (providing arrangements are made on main switchboards, etc.) irrespective of existing shafting, motors, etc. Our installation will include a special

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motor for driving a goods lift, and two for driving ventilating fans; the dynamos are so arranged that one or two can be driving the machinery, whilst the third is lighting some 1,000 to 1,200 16-c.p. lamps, besides arc lamps for photographic studio purposes.

We are not yet in a position to make any tests as to relative cost of driving—in fact, it will be very difficult to arrive at, seeing that the same engine drives the old portion of our works by shafting as well as the generators. Nor have we yet been able to test the relative steadiness of the driving, but as the speed of the motors can be adjusted by the resistance switch, we have good reason to believe that we shall have greater facilities as to regulation of speed (which can be purposely altered to suit the work in hand) than with shafting.

I venture to think that by the time we have completed our installation that we shall have given the question a thoroughly practical test such as you suggest, and I shall have much pleasure in showing the same to you.—I am, Sir, yours, etc., W. WRIGHT BEMROSE.

Midland-place Printing Works, Derby, June 27, 1896.

TRANSFORMER SUB-STATIONS AT READING.

The transformer sub-stations fitted up at Reading by Messrs. Paterson and Cooper are good examples of the most recent practice in this direction. When deciding upon the arrangement of these stations, the Reading Company decided that they should be erected above ground, instead of being underground chambers. There are at present two stations, the one in Friar-street being erected specially, and having the whole of the apparatus contained in one room on the ground floor. For the other station in West-street a small cottage has been utilised, the transformers being placed in watertight cases in the cellar, and the switchboards, etc., in the room above on the ground floor, the upper floor being cut away and fitted with skylights.

graph of one of the high-tension boards complete, with the front slate panels removed. Fig. 3 shows in section the construction of the board. There are five switches on the board, one receiving the full amount of 60 amperes from the high-tension mains, and the remaining four carrying 15 amperes each for the transformers. Each switch is double-pole, and for each pole provision is made for a short-circuiting plug. An ampere-meter is placed at the top of the board, and is provided with a short-circuiting plug in

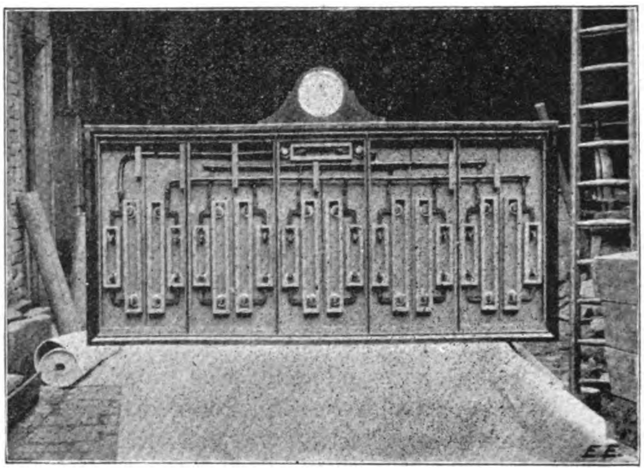

FIG. 2.—High-Tension Board, with Front Panels Removed.

case it is desired to disconnect it. The whole of the current-carrying metalwork is mounted on porcelain insulators fixed to the back slate. The board is framed in teak, and the front closed with enamelled slate panels, having slots through which the switch blades pass. Thus there is absolutely no exposed metalwork at the front of the board, while at the back the only pieces of metal coming through are the terminals, and these are boxed over to prevent accidental contacts. Each switch consists of a pair of knife blades, which slide

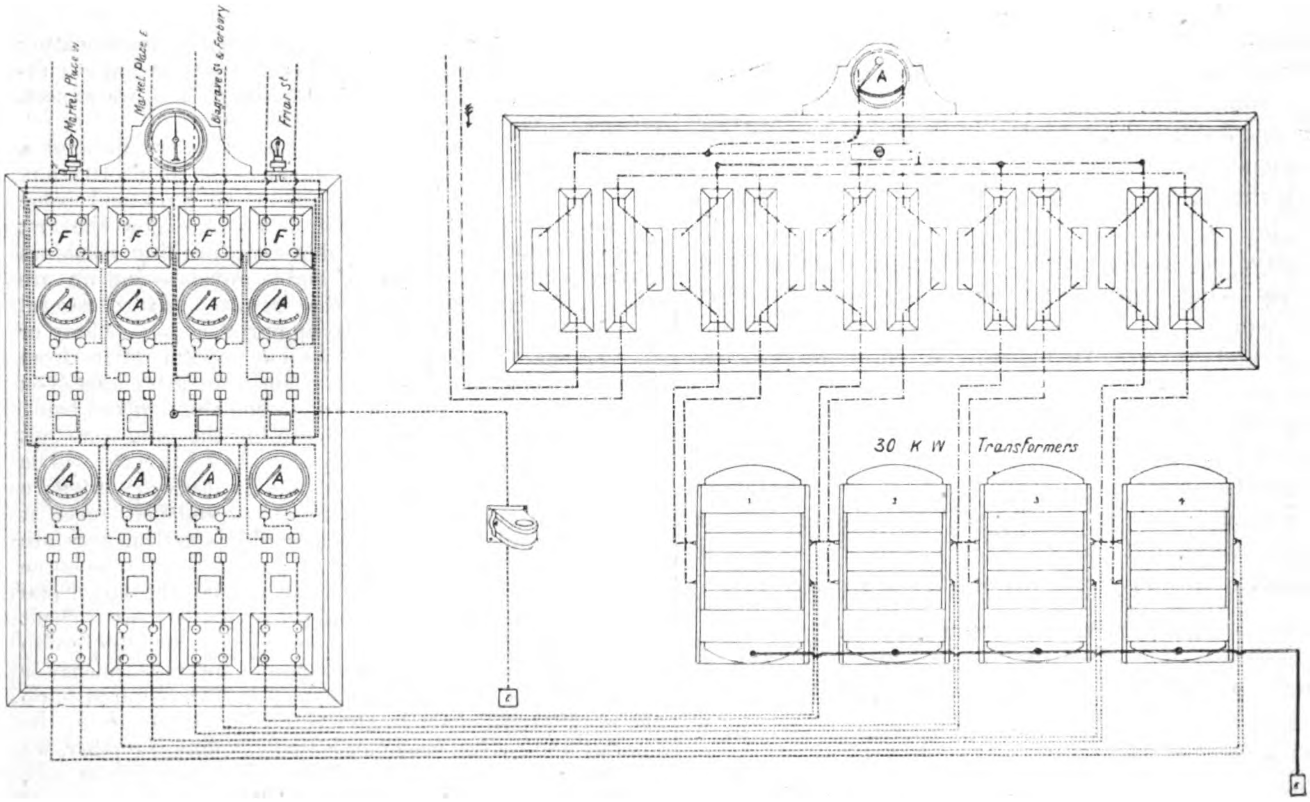

FIG. 1.—Diagrammatical Arrangement of Connections.

Fig. 1 shows diagrammatically the arrangement of connections adopted, which is similar in both stations. The high-tension connections are made with Silvertown cables, Class C, 2,500 megohms per mile, and the low-tension connections with Callender's standard vulcanised cables, 0·4 square inch area solid cored. Fig. 2 is from a photo-

into spring contacts on the board, mounted on a piece of slate, which is again mounted on a polished teak bar with ebonite handle. The blades are connected together by fine wires so that a combined switch and fuse is obtained. Slate slips standing perpendicularly to the board are placed between the poles, so that each pole of each switch is

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confined in a separate compartment of slate. This is no doubt one of the safest forms of high-tension switchboard which has yet been devised.

The switches on the low-tension boards are Messrs. Paterson and Cooper's D.P. hatchet type. The amperemeters are a new design of gravity instrument, suitable for direct or alternating currents. For any frequency from 40 to 100 they are practically correct without recalibration, while when calibrated for direct currents, the error, if placed on an alternating circuit of 100 periods, does not exceed

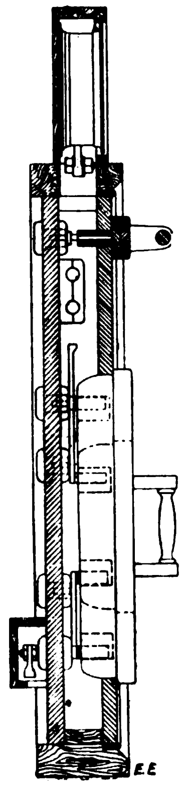

FIG. 3.—Section of High-Tension Board.

2 per cent. The double-pole fuses are protected by hinged cases with glass fronts, so that should a fuse blow when the attendant is near there is no fear of his being struck by the pieces of molten metal. Both the high and low tension boards are mounted in polished teak frames, and are placed about 18in. from the walls of the stations, doors being fitted at the ends of the boards to give access to the back connections.

The arrangements described are the joint design of Mr. F. F. Yeatman, engineer to the Reading Supply Company, and Mr. C. W. Hill, manager to Messrs. Paterson and Cooper.

AWARD OF THE EVENING EXHIBITIONS.

The examination papers for the award of the evening exhibitions in science and technology were published in the June number of the *London Technical Education Gazette.* We gathered that there were 88 of these exhibitions awarded this year. The examiners' report is most interesting, and we find that these exhibitions are of the value of £5 per annum, and are tenable for two years. They correspond generally with the evening art exhibitions, and are held under very similar conditions. The payment is made to each exhibitioner in four quarterly instalments, and is intended to cover the amount of his class fees and travelling expenses incurred in attending evening classes. Not more than 100 were offered for competition in April last, and for these 285 candidates sent in their names, of whom 47 failed to present themselves for the examination, which was conducted simultaneously at the People's Palace, Regent-street Polytechnic, the South-West London Polytechnic, Battersea Polytechnic, the Borough Polytechnic, and Woolwich Polytechnic. Of the candidates 33 submitted works of various kinds, and 50 submitted drawings generally relating to building construction, machine construction, or practical geometry. Among the works submitted there were a number of very good examples of lead bossing, and there were some other specimens of actual pieces of work, but there were too many examples of unworkmanlike work such as one expects to see exhibited by amateurs at industrial exhibitions. There were a few good examples of building construction carried out necessarily on a small scale, but useful as models for teaching purposes, but there were also examples of very serious waste of time in the construction of models of no conceivable use except as illustrating the patience and perseverance of the workers.

Of the drawings submitted there were several sheets of rough sketches apparently made in classes from lecture diagrams, and useful in their way as showing the nature of the class teaching in some of the technical institutes and classes. There were also some well-finished drawings of a practical character, but there were many serious examples of time and opportunity wasted in the mere copying of "pictures," the copyists, in some cases, obviously having no idea of the constructional details of the mechanism they were representing, while in many cases the chief feature of the work was the high and varied colouring. One candidate who entered for machine construction, but gained only 7 per cent. of the possible marks in the paper on that subject, submitted a sectional drawing in pencil of a locomotive on the North London Railway. The drawing had occupied between 200 and 300 hours, and was full of the most carefully-executed and minute details. Had it been submitted by a lithographic or wood-engraver's draughtsman it would have deserved credit for the accuracy of its technique, but as the work of an engineer's apprentice it is an example of serious waste of time. Of the drawings of engines there were two very similar in general character and both neatly finished in water-colour, but of widely different educational value. One represented a 40-h.p. horizontal engine of about 100 years ago, full of elaborate architectural decoration, carried out in cast iron, and apparently copied from some published lithograph. The other was also a drawing of a horizontal factory engine, but an engine which had been recently erected in Woolwich Arsenal and was provided with Proell trip gear, but the chief feature of the drawing was that it had been executed from dimensions taken by the candidate himself on the actual engine. There can be no comparison made between the educational value of these pieces of work.

In analysing the results of the examination for evening exhibitions in science and technology, and comparing them with the results of last year, it is interesting to note an increase in the number competing, and also in the number of exhibitions awarded. A much larger proportion of the successful candidates previously attended classes in polytechnics or other institutions aided by the Board, the proportion being 84 per cent. as against 76·6 per cent. last year, whereas the number obtaining exhibitions from continuation schools is much less, being 6·8 per cent. as against 14·3 per cent. The number submitting specimens of practical work is also much greater this year than last. The majority of the successful candidates consist of men engaged in engineering, building, carpentering, and plumbing trades. The class of students attracted by these exhibitions is exactly the class for whom they were specially designed by the Board.

Of the 88 successful candidates 73 have attended classes at polytechnics—viz., at Battersea 23, at the People's Palace 22, at Woolwich 10, at Regent-street 8, at the South-West London 4, at the Borough 2, at the Goldsmiths' Institute 2, at the Birkbeck Institution 1, and at the City of London College 1.

The following was the paper set for this examination in electricity and magnetism and electrical engineering. The candidates were not expected to answer more than eight questions:

1. What is meant by a magnetic field of unit strength? Explain fully the meaning of the statement that the magnetic induction in the armature core of a dynamo is 12,000 C.G.S. units, and point out the advantage of keeping this induction as low as possible.

2. Describe a good form of tangent galvanometer. What is the "constant" of a galvanometer, and how would you determine it?

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3. Mention the principal methods available for the measurement of an electric current of a few amperes and describe fully the manner in which you would measure a current by means of a calorimeter.

4. Describe the construction of some form of ampere-meter or voltmeter suitable for an ordinary switchboard.

5. A country house is to be lighted by means of storage cells charged by a dynamo, the battery-room being in the immediate proximity of the engine-room. Make a sketch of a suitable switchboard containing all the instruments, switches, and accessories which you consider desirable for the purpose, showing all the connections, but omitting the details of the instruments.

6. What is meant by the characteristic of a dynamo? Sketch the characteristics of a pure shunt dynamo and of a series dynamo. What class of dynamo would you select for the purpose mentioned in the last question, and why?

7. A building has been wired with 20 independent circuits proceeding from a distributing double-pole fuse-board. You are required to test the circuits in order to ascertain whether they satisfy insurance regulations. What instruments would you employ, and how would you proceed?

8. A length of 110 yards of "concentric" cable has developed a fault between the two conductors. How would you proceed to ascertain the precise position of the fault, both ends of the cable being accessible in the test-room?

9. Describe some form of arc lamp suitable for alternating current. You have to arrange two 25-ampere arc lamps on an alternating circuit in which the current is supplied at 100 volts. What arrangements would you make?

10. Describe the construction, including the winding, of some good form of armature for a continuous-current dynamo.

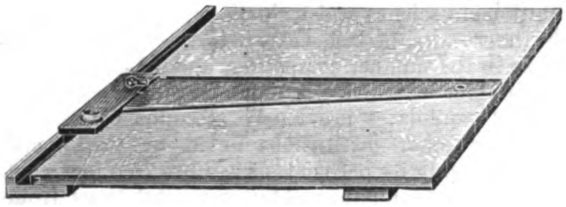
11. A current of 1,000 amperes is carried through a mile of copper conductor of one square inch sectional area. If the fall of potential be one volt for every 40 yards, how many horse-power will be wasted in heating the conductor?

What saving of power would be effected if the same energy were transmitted through the cable by means of half the current at double the pressure?

12. Describe Lord Kelvin's milliampere balance.

THE STANLEY-HOWARD COMBINED DRAWING-BOARD AND TEE-SQUARE.

We were shown this improvement recently, and think it should find favour with draughtsmen. The form of the apparatus, which is patented, is seen in the illustration. The object of the invention is to provide a tee-square which can be easily



and truly clamped to the board at any point. To enable this to be done the end frame is made of an L section, so that a groove is left at the end of the drawing-board, in which the tee-square slides. This groove is not used as a guide, but the edge of the drawing-board determines the position of the tee-square in the usual way. The head of the square has projecting through it a small bolt with a lever on its upper end and a cam at the other. When the lever is turned the cam engages on the side of the L frame, and forces the true surface of the square against the turned surface of the drawing-board. A little extra pressure on the lever then secures the square in position, so that the draughtsman can work on the extreme end of the blade without holding the square. This will be found to be of great assistance when fine work with the set square has to be done, as it permits the draughtsman to use both hands. The construction of the clamping device is such that all the pressure of the metallic part of the cam only affects the frame and not the trued surfaces. The frame also protects the adjusted edge of the board from mechanical injury. Another handy detail in the square is that of allowing the blade a slight swivel when required. So in putting back old drawing on to the board the square can be set to the drawing, instead of the old practice of adjusting the drawing to suit the square.

This adjustable square will be found of great service when working at the extreme lower edge of the board. We understand that these sets are to be obtained from Messrs. Stanley and Co., Great Turnstile, at reasonable prices.

THE CONVERSION OF THERMOMETER READINGS.

BY A. H. ALLEN.

It is frequently necessary to convert readings of temperatures which have been observed on the Centigrade scale into the corresponding values on the Fahrenheit scale, and *vice versâ*. For this purpose tables have been compiled, but these usually advance by steps of one degree, and therefore involve calculation in the case of fractional values.

To convert from °C. to °F., therefore, it is usual to multiply by $\frac{9}{5}$ and add 32, and to convert from °F. to °C. subtract 32 and multiply by $\frac{5}{9}$.

An easier method by which the operation may be performed mentally, in less time than it takes to get a sheet of paper and write down the figures, and which is perfectly accurate, is given below.

(i.) To convert °C. into °F.:

Since $\frac{9}{5} = 1{\cdot}8 = 2 - {\cdot}2$, multiply by 2, from the product subtract the same figures *moved one place to the right*, and add 32. Thus, to convert 73° C. into °F.:

	73
Multiply by 2	2
	146
Repeat figures one place to right	14·6
Subtract...	131·4
Add 32	32
	163·4

Hence 73° C. = 163°·4 F.

(ii.) To convert °F. into °C.:

$$\tfrac{5}{9} = {\cdot}55555 \;.\;.\;.\;.\;.$$
$$= {\cdot}5 + {\cdot}05 + {\cdot}005 + \;.\;.\;.\;.$$
$$= \tfrac{1}{2} + \tfrac{1}{20} + \tfrac{1}{200} + \;.\;.\;.\;.$$

Therefore, subtract 32, divide by 2, and to the quotient add the same figures twice or thrice, *moved one place to the right each time*. Thus, to convert 80° F. into °C.:

	80
Subtract 32..	32
Divide by 2..	2)48
	24
Repeat figures one place to right............	2·4
Repeat this..	·24
	26·64

Hence, 80° F. = $26{\cdot}\dot{6}$° C.

The result in this case is always a recurring decimal, from the nature of the multiplier—*i.e.*, $\cdot\dot{5}$; and therefore the process must be carried far enough to indicate the correct value of the last figure.

Both of these processes can easily be done mentally, as will be found on trial, and with far less trouble than is involved in finding the tables or working out by the ordinary method.

REFUSE DESTRUCTION AT DEWSBURY.

A short time ago a new refuse destructor on the Beaman and Deas system was started at Dewsbury. The illustrations we give herewith will save a lengthy description. The destructor furnaces are built in pairs, and each has an inclined hearth leading from a tipping platform 8ft. 9in. in height to a horizontal fire-grate. Beyond the grate there is a fire-bridge, and beyond this bridge a screen of perforated brickwork, the space between the bridge and the screen forming what is known as the combustion chamber, which is common to both furnaces. A reverberatory arch stretches over the combustion chamber, fire-grate, and hearth, from front to back. The ashpit is hermetically sealed and forced draught is let into it by means of a fan. In order to utilise the heat generated, a water-tube boiler of the Babcock and Wilcox type is erected behind each pair of furnaces. The fumes from the charge lying upon the hearth pass through

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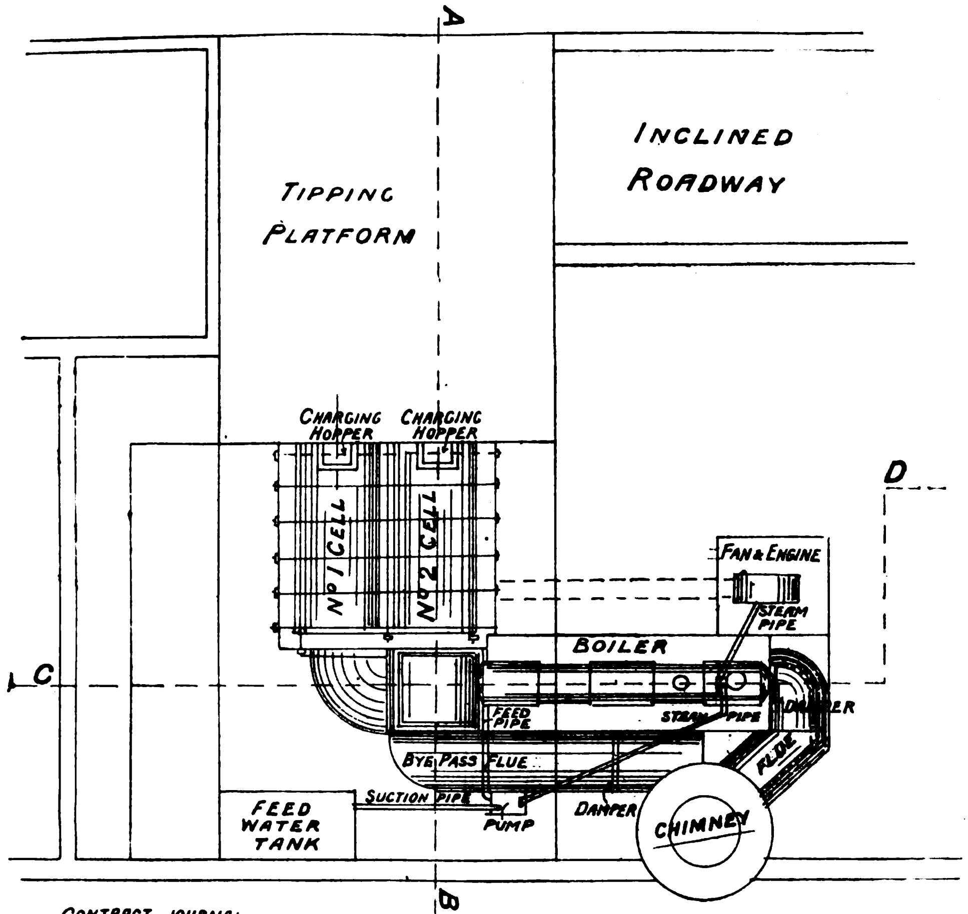
the fire directly over the fire-bars. The fire-bridge is hollow, and perforated at the back. The perforations communicate by a passage with the outer air, and a strong draught is created, the air in its course being heated, and giving, on its escape into the combustion chamber through the perforations of the bridge, a supply of heated oxygen, which meets any fumes passing over the bridge, and thus ensures their perfect combustion. The action is, in fact, similar to that of a Bunsen burner, so familiar to our readers.

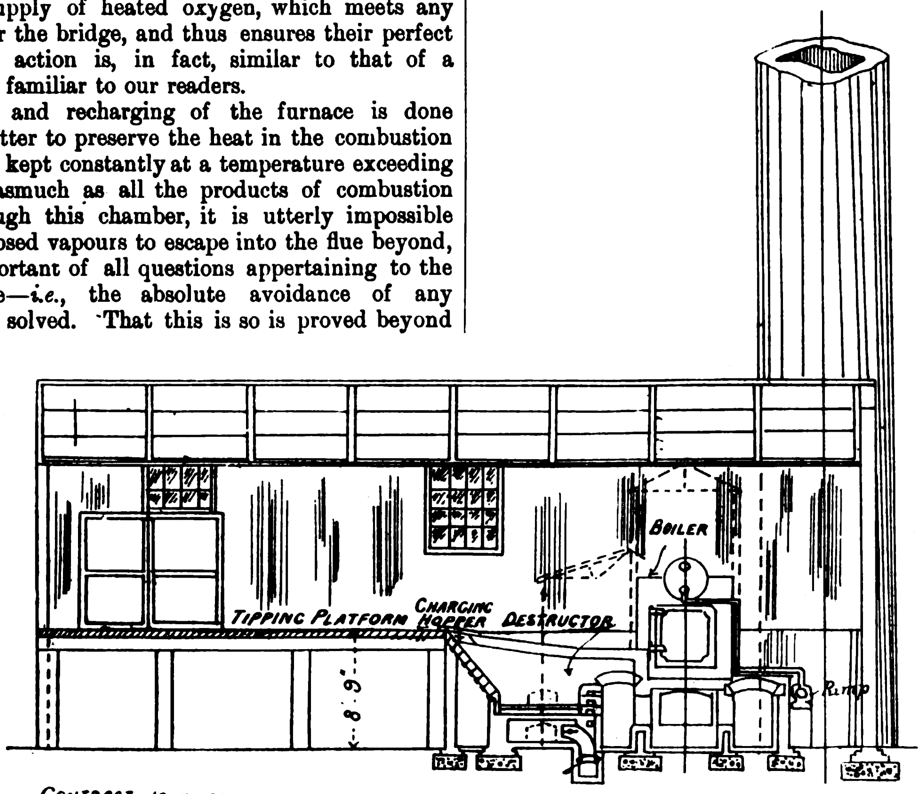
The clinkering and recharging of the furnace is done alternately, the better to preserve the heat in the combustion chamber, which is kept constantly at a temperature exceeding 2,000deg. F. Inasmuch as all the products of combustion have to pass through this chamber, it is utterly impossible for any undecomposed vapours to escape into the flue beyond, and the most important of all questions appertaining to the disposal of refuse—*i.e.*, the absolute avoidance of any nuisance—is thus solved. That this is so is proved beyond doubt by repeated analyses of the gases as they pass to the chimney shaft.

It might be expected that the great heat generated would destroy the firebrick lining of the furnaces, but this is not the case. The siliceous particles given off by the burning refuse attach themselves to the roof of the furnace and the surrounding brickwork in a stalactytic form, and thus provide a complete protection, consisting of a material which is a non-conductor of heat. Indirectly, therefore, the high temperature is the means of preserving the brickwork.



PLAN

Dewsbury Refuse Destructor.



SECTION A.B.

Dewsbury Refuse Destructor.

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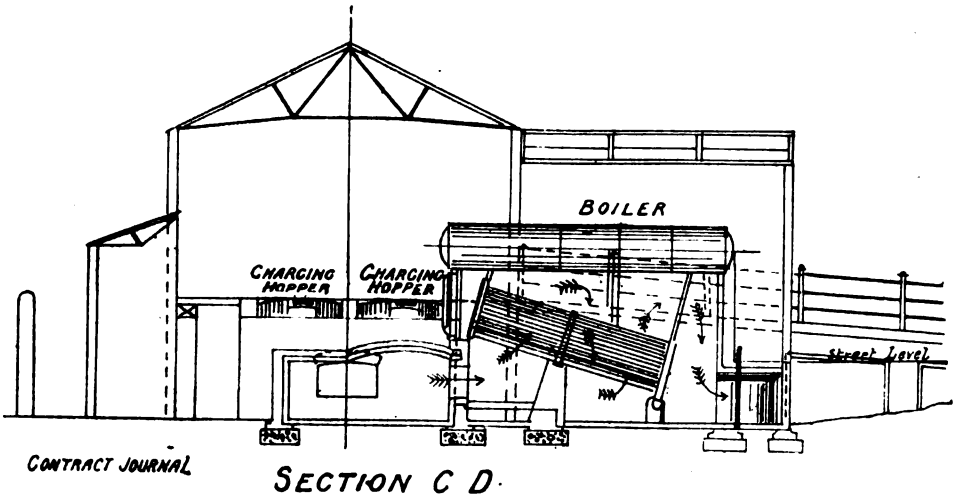
Messrs. Bennett and Druce, electrical engineers, of Preston, have recently made a test with a two-cell destructor and a Babcock and Wilcox boiler at Warrington. The refuse used as fuel for this test contained 48 per cent. of moisture and only 30 per cent. of combustible material. Nevertheless sufficient steam was raised to develop 200 i.h.p. per hour.

This destructor has been proved capable of burning, when worked to its full capacity, 24 tons of unscreened town's refuse per cell per day of 24 hours. Where, however, the best steam results are desired it is not always advisable to force the consumption. The incombustible residuum has been found to average from 15 per cent according to the nature of the refuse, and forms a very hard clinker, which is of value for road foundations, making mortar, and other purposes. Mixed with cement, and subjected to hydraulic pressure, it forms valuable pavement flags, equal if not superior to the best Yorkshire stone.



Dewsbury Refuse Destructor.

PHYSICAL SOCIETY.

At the ordinary meeting on June 26, Captain Abney, president, in the chair,

Mr. F. Bedell read a paper on **"Admittance and Impedance."** The author discussed the application of the method of "vector diagrams" to the solution of questions connected with alternating currents. He showed how, by a consideration of the loci of the different lines on such a diagram, many problems which require for an analytical solution a long investigation may be simply and expeditiously solved.

Mr. Blakesley asked the author what was his test of resonance. Was it that the primary current and E.M.F. were exactly in the same or in opposite phase? The term resonance was an acoustical one, and he did not see why it should be applied to one particular case in the electrical problem.

Mr. Inwards asked what degree of accuracy the author had obtained.

The **Author**, in reply, said if the applied E.M.F. and the current were brought into phase by means of a condenser in the secondary, then he called that a case of resonance. The agreement between the experimental and theoretical results was generally within from 1 to 3 per cent.

Prof. S. P. Thompson read a paper on **"The Properties of a Body having a Negative Resistance."** The author, after showing the consequences which would follow according to the laws of Joule and Ohm if the existence of a body having a negative resistance were postulated, went on to show how the observations described by Messrs. Frith and Rodgers in a paper read at a recent meeting of the society only proved that that part of the resistance of an arc which is not constant is a positive resistance that varies inversely as the current. Since it varies inversely as the current, the term $\frac{dR}{dC}$ will be negative, and so will the quantity $C\frac{dC}{dR}$, which is what they had tabulated as a negative resistance. That the resistance of the arc itself should vary inversely as the current was natural, for it might be regarded as a column of vapour, the cross-section of which is proportional to the current, and therefore increasing in its conductance in direct proportion to the current. There was no need even to suppose any (distributive) adjuvant E.M.F., which would be the other alternative to the suggestion they had made.

Mr. Swinburne asked if the numbers on which Messrs. Frith and Rodgers based their arguments were obtained by taking successive readings of a voltmeter.

Prof. Ayrton said that what they maintained was that if the arc acted as if it had a back E.M.F. and a resistance, then the resistance was a negative quantity. In ordinary cases it was not known what really constituted a resistance, but it was simply said that a circuit in which electrical energy is being dissipated at a rate proportional to the square of the current has resistance. If the loss is proportional to the first power of the current, then it was said there existed a back E.M.F. Was it impossible to imagine a circuit in which a loss of electrical energy occurred proportional to the current and a return of energy to the circuit proportional to the square of the current? In a curve showing the relation between V and C, if a tangent was drawn at any point it was not the tangent of the inclination of this tangent which Messrs. Frith and Rodgers had called the resistance; it was another quantity, which they called the electrical $\frac{dV}{dC}$. In conclusion, the author seemed to have based his paper on three misconceptions—(1) that it had been claimed that a negative resistance could exist alone; (2) that the curves given by Messrs. Frith and Rodgers showed that the ordinates were inversely proportional to the current; (3) that what was measured was the geometrical $\frac{dV}{dC}$.

Mr. Frith said that in a paper by Mr. Rodgers and himself they had defined the resistance of the arc as the ratio $\frac{dV}{dC}$, where by $\frac{dV}{dC}$ they meant, not what was ordinarily understood by this expression, but the value of the ratio obtained by superposing an alternating current on a direct current arc. In order to show that in cases analogous with that of the arc, but in which the true resistance could be verified, the electrical $\frac{dV}{dC}$ obtained by superimposing an alternating current gave correct results for the resistance, some experiments had been carried out. In one case an incandescent lamp was placed in series with some 50 ampere secondary cells and a current sent through against the E.M.F. of the cells. The value obtained for the electrical $\frac{dV}{dC}$ agreed very well with the value of the resistance obtained by dividing the P.D. between the terminals of the lamp by the current. At very low frequencies for the superimposed alternating current it was evident that the electrical oscillations could travel along the steady value curve and this was clearly the meaning of the critical frequency observed with cored carbons—namely, that under the critical frequency the superimposed alternating current travelled on the steady value curve, and over that frequency along the line joining the point on the curve and the instantaneous origin. Mr. Frith exhibited a mechanical model of the arc which he has devised. This model consists of two rods of carbon dipping in two mercury cups, which are traversed by the current. The current also passes through a solenoid, which attracts an iron core attached to the carbon rods and draws them down into the mercury, thus reducing the resistance of the instrument. Hence it can be arranged so that the P.D. between the terminals decreases as the current increases. With this model it was found that for superimposed oscillating currents of such a frequency that the moving parts are not able to follow the changes in the current, the oscillations of the current and of P.D. are in phase, and the electrical $\frac{dV}{dC}$ gives the resistance of the apparatus for various currents.

Mr. Carter asked the author how on his vapour column theory he explained the difference in the behaviour of solid and cored carbons.

Mr. Enright asked why it was absurd to suppose that a negative resistance could exist. Prof. Ayrton and Mr. Frith had made in their definitions certain restrictions; it ought, however, not to be necessary to make any such restrictions.

Mr. Blakesley asked whether, since the title of the paper by Messrs. Frith and Rodgers was the "*True* Resistance of the Arc," it was to be inferred, as the results given were negative, that a negative ohmic resistance existed in the arc. Prof. Thompson's

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paper appeared to him (Mr. Blakesley) to be rather a mathematical than a physical paper.

Prof. Rucker said that the discussion showed that considerable confusion existed, and that the introduction of the term negative resistance only tended to fog matters. It was entirely wrong to argue that because you have a quantity with a positive value, therefore a negative value must also be possible. As an example, take the case of mass. If you defined as a positive mass that which was attracted to the earth, and then found that cork when immersed in water was repelled from the earth, would you therefore say that cork had a negative mass? Was not "negative resistance" a term for which some equivalent could be found which would not lead to confusion?

Mr. Hovenden made some remarks on his experiments

The **Author**, in his reply said that he did not dispute the accuracy of the results obtained by Messrs. Frith and Rodgers, but it was the interpretation which they had given of their results to which he objected. Mr. Frith now made a new reservation—namely, that the results depended on the particular way in which the increment of C and the decrement of V were made. He supposed that, if the experiment was made in a particular way, a new slope was obtained which was proportional to what was called the true resistance, and hence got a new definition of the quantity $\frac{dV}{dC}$. He (the speaker) endorsed the views of Prof. Ayrton as to the interest of the model exhibited, but the question was, Is there anything in the arc which acts as a source of energy to the circuit, either as a negative resistance or as an adjuvant E.M.F.? Mr. Frith's experiments did not give any hint as to the point where the negative resistance occurred, and the absence of any such energy-giving portion of the arc was rendered probable by the fact that the arc itself was hotter than the crater. In reply to Mr. Carter, the anomalies which occur with cored carbons were so great as to prevent any argument being based on their behaviour.

The **Chairman** (Captain Abney) said that the mere fact that the quantity $\frac{dV}{dC}$ had been defined in two distinct ways showed that the definitions would have to be modified in some way.

MANCHESTER ELECTRICITY ACCOUNTS.

The following is the report of the electric light department to the City Council for the year ended March 31, 1896, together with the revenue account, the general balance-sheet, and statement of electricity generated, sold, etc.:

Your committee have pleasure in submitting to the City Council the abstract of accounts for the year ended March 31, 1896, and also in reporting the following particulars as to the year's working. The number of consumers at the close of the year was 1,148, being an increase of 407 as compared with the previous year. The number of lamps connected was—incandescent 89,294 (of 8 c p.), arc 806, as compared with 60,632 and 385 respectively. There were also 47 motors at work representing 54½ h.p., being an advance on the previous year of 30 motors, equal to 38½ h.p. The total length of mains laid was 113 miles 742 yards. The total quantity of current accounted for was 1 801,429 units, or 93·49 per cent. of the quantity produced. As will be seen from the accounts, the financial results of the year have been good. The net profit, after defraying all charges for cost of production, etc., provision for renewals, sinking fund, and interest on loans, amounts to £11,138. 10s.

Revenue Account.

The amount derived from sales of current, which works out to 4·97d. per unit accounted for, was		£37,369 4 4
The meter rents received amount to		883 8 3
Making a total income of		£38,252 12 7
The expenditure was	£14,211 5 2	
To which is added amount transferred to renewals account	3,491 14 9	
		17,702 19 11
Showing a gross profit of		£20,549 12 8
Out of this sum the following requirements had to be met:		
Interest on mortgage debt, etc	5,149 4 6	
Sinking fund	4,261 18 2	
		9,411 2 8
Leaving a surplus or net profit for the year of		£11,138 10 0

This surplus, together with the balance of £5,499. 8s. 8d. brought from last year's account, making a total of £16,637. 18s. 8d., has been appropriated as follows:

Paid to city fund in aid of rates	£6,963 14 9
Placed to contingent fund	8,521 3 11
Carried to next year's account	1,153 0 0
	£16,637 18 8

The financial position of the undertaking at March 31, 1896, is as follows:

Total capital expenditure	£251,689 12 9
Amount of capital redeemed to date by action of sinking fund	£9,186 4 0
Balance at credit of renewals account	£7,491 14 9
Balance at credit of contingent fund	8,521 3 11
Balance at credit of net revenue account	1,153 0 0
	£17,165 18 8

The following additions have been made to the plant at the works, Dickenson-street, during the year—viz: five Lancashire boilers, with mechanical stokers; six compound condensing engines (five vertical and one horizontal) of 400 i.h.p. each; six dynamos, each of 240-unit capacity. The extension to the boiler-house is finished, also the new economiser house and feed-water tank together with the two new economisers. The battery station, Hunt's Bank, is completed, and is now ready to be charged; two new transformer sub-stations have been completed, one at Ardwick-green, the other at All Saints, and the transformers have been fixed in the latter station. The extensions of mains referred to in last year's report have been completed, and the committee are now in a position to supply current to consumers in the following streets—viz., Oxford-street, Stretford-road, London-road, Downing street, Port-street, Sackville-street, Chorlton street, Minshull-street, Swan-street, Whitworth-street, Shudehill, Withy-grove, Fennel-street, and Hunt's Bank. The demand for the supply of electricity has been and continues to be so great that further extensions of mains are imperatively necessary, and it has been decided to lay them in the following streets—viz., Great Ducie street and Bury New-road, Miller-street and Great Ancoats-street, Corporation-street, Lower Mosley street, Ardwick-green, Grosvenor street, Upper Brook-street, Great Jackson street and Upper Jackson-street, and also in the district of Victoria Park which will be supplied with current at 200 volts on the three-wire system. The provisional order authorising the above extensions of mains, and also extending the area of supply to the whole city, has been sanctioned by the Board of Trade, and is now awaiting the approval of Parliament. In accordance with resolution of the City Council, application has been made to the Local Government Board for permission to borrow the further sum of £100 000 to carry out the foregoing extensions, which are expected to be partly available for the ensuing winter.

GENERAL BALANCE-SHEET.

Liabilities.	£ s. d.
Mortgage debt—loans as per capital account	£240,813 16 0
Amount owing to city treasurer for wages advanced	338 18 1
Deposits held as security for current supplied	824 15 8
Interest accrued on ditto	19 18 6
Trade accounts owing	6,551 1 3
Amount at credit of net revenue account	1,153 0 0
Amount at credit of renewals account	7,491 14 9
Amount at credit of contingent fund	8,521 3 11
Surplus balance—mortgages redeemed by sinking fund	9,186 4 0
	£274,900 12 2
Assets.	£ s. d.
Lands, buildings, plant, etc—amount expended	251,689 12 9
Stocks on hand	1,986 1 11
Cash at bankers	8,141 17 4
Sundry debtors—accounts due for current supplied	12,882 3 10
Other accounts due	126 4 5
Cashier, cash in hand	74 11 11
	£274,900 12 2

REVENUE ACCOUNT.

Dr. Generation of Electricity.		£ s. d.
Coal (including cost of unloading, etc.)	£3,048 15 4	
Oil, waste, water, and engine-room stores	1,108 19 6	
Wages at generating station	2,301 16 11	
Repairs and maintenance of buildings, £60. 10s. 2d.; engines, boilers, dynamos, switchboards, cranes, transformers, stokers, etc., £1,002. 13s. 9d.; tools, £48. 7s. 5d.	1,111 11 4	
Current used on works, etc., for lighting and motive purposes. £581. 15s. 2d., and maintenance of lamps, etc. (lighting of station), £53. 8s. 8d.	635 3 10	
		8,206 6 11
Distribution of Electricity.		
Wages	492 19 6	
Sundries	191 6 2	
Repairs and maintenance of machinery, etc., at distributing stations, £15. 19s. 2d.; mains, fuses, etc., £341. 4s. 9d.; meters, £87. 17s. 5d.; and tools, £145. 2s.	590 3 4	
		1,274 9 0
Rents, Rates, and Taxes.		
Chief rents	124 3 8	
Rents of sub-stations, etc.	140 0 4	
Rents of telephones	26 0 0	

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Rates	708	6	8			
Income tax	585	14	0			
				1,584	4	8
Management Expenses.						
Salaries, viz.—engineer's department (including C. H. Wordingham, £500)	1,051	6	1			
Superintendent's department and clerical staff	787	5	9			
Stationery, printing, and advertising	287	18	0			
General establishment charges	305	10	0			
				2,431	19	10
Law and Parliamentary Charges and Expenses.						
Law charges	3	0	0			
Stamp duty	134	14	9			
				137	14	9
Special Charges.						
Insurances	9	9	0			
Bank commission (including £2. 17s. 4d. transferred from sinking fund account)	37	5	1			
Contributions to Manchester Corporation Thrift Fund	35	9	9			
Commission on loans	424	16	6			
Repairs and maintenance of office furniture	32	7	5			
Official clothing	20	13	3			
				560	1	0
Bad debts—amount written off				16	9	0
				14,211	5	2
Renewals account—amount transferred, being difference between the estimated wear and tear (or depreciation) of buildings, machinery, mains, etc., during the year (£5,000), and the repairs and maintenance actually charged (£1,580. 5s. 3d.)				3,491	14	9
Balance carried to net revenue account				20,549	12	8
				£38,252	12	7
Cr.				£	s.	d.
Sales of current				37,369	4	4
Rental of meters				883	8	3
				£38,252	12	7

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC., DURING 1896.

Quantity generated, B.T. units	1 926,900
Quantity sold to private consumers	1,748,244
Quantity used on works	53,185
Total quantity accounted for	1,801,429
Quantity not accounted for	125,471
Total maximum supply demanded (watts)	2,082,600

LEGAL INTELLIGENCE.

ENGINEER AND COMMITTEEMAN.

On Friday last in the Queen's Bench Division the action of Medhurst *v.* Kyffin begun the previous day before Mr. Justice Kennedy and a special jury was concluded.

Sir E. Clarke, Q.C., Mr. C. W. Mathews, and Mr Hugh Fraser appeared for the plaintiff; Mr. Cock, Q.C., Mr. Eldridge, and Mr. George Blaiklock for the defendant.

The plaintiff in this case, Mr. F. H. Medhurst, electrical engineer, of 13, Victoria-street, Westminster, sued Mr. J. B. Kyffin, of Oval House, 461, Hackney-road, who is a member of the Electric Lighting Committee of the parish of Hackney, for damages for slander, the allegation being that the defendant had spoken to Mr. G. Raper, another member of the Electric Lighting Committee of the parish of Hackney, the following words: "I say, have you heard the scandals that are going about in reference to the Electric Lighting Committee? I hear that Medhurst has given Sheehan £50. . . . Yes, I understand he has given him a £50 note." The plaintiff also complained that the defendant upon subsequent occasions repeated the slander. The Mr. Sheehan referred to was the chairman of the committee which had reported in favour of plaintiff's scheme. It was pleaded in defence that the statement was made by the defendant as a member of the Electric Lighting Committee of the parish of Hackney and in pursuance of his duty as such member, and the words were spoken *bonâ fide* and without malice, and were therefore privileged.

For the plaintiff, **Sir E. Clarke** said Mr. Medhurst was engaged in 1895 by the Hackney Vestry to advise upon electric lighting. The committee visited a number of the principal towns to obtain information, and the defendant took his son with him. The son wanted to become an electrical engineer, and defendant asked the plaintiff to take him into his office. The plaintiff refused, and that seemed to be the motive for the slander. The defendant being asked for the name of his informant in the matter, on some occasions said it was Mr. Pressland, a former employé of the plaintiff's, and at other times that it was not. The Electric Lighting Committee reported in favour of the plaintiff's scheme of electric lighting, but the matter had now been postponed, and the plaintiff had suffered a serious loss.

Evidence was called to prove the plaintiff's case, and **Mr. Cock**, for the defence, urged that the occasions upon which the statements were made were privileged. The defendant was only acting in accordance with his duty, and was only anxious that the scandal should be investigated, and had merely spoken confidentially to a fellow-member of a public body. It was the duty of every public man to enquire into any charges of corruption.

Mr. Kyffin, the defendant, was called in support of this, and denied having been actuated by any ill-feeling whatever towards the plaintiff.

Mr. Justice Kennedy, in summing up, said that he should hold that the occasions upon which the statements were made were privileged, and the question for the jury was whether, therefore, there was any such malice on the part of the defendant as to take it out of the privilege. Although no special damage had been shown, a slander upon a professional man was no doubt a serious matter.

The jury found a verdict for the plaintiff, with £400 damages.

COMPANIES' MEETINGS AND REPORTS.

INDIA RUBBER AND TELEGRAPH WORKS COMPANY.

The half-yearly meeting of the shareholders of the India Rubber, Gutta Percha, and Telegraph Works Company, Limited, was held on Tuesday at Cannon-street Hotel, E.C., Mr. Matthew Gray (managing director) presiding.

In moving the payment of an interim dividend of 2½ per cent., or 5s. a share, free of income tax, the **Chairman** said the amount of business transacted during the last six months had been about 10 per cent. greater than in any previous half-year. This was a matter for congratulation, but the additional business had not been so profitable as they could have wished, because the raw material had increased in price something between 10 and 15 per cent. There was also great competition, so that it was not easy to secure great profits on orders, but taking all things into consideration there was every reason to be satisfied with the result, and they might reasonably expect that the increase of business would continue. With reference to submarine cable work, they had had a number of cables to lay at Cuba, and very little time to do it in. But they had managed to do it, and the Cuba Company were well satisfied. Since then they had had an order of considerable magnitude from the German and English Governments. The laying of this English and German cable was a somewhat difficult piece of work owing to the shallowness of the water in some parts of the line taken.

Mr. S. W. Silver seconded the resolution.

Mr. Grant asked if the Company was likely to be involved in litigation with one of the cycle-tyre companies.

The **Chairman** said that they were advised that certain of their patents had been infringed and had taken action in the matter, but the case was not likely to come on at present. In reply to a further question, he added that, so far as he knew, their opponents had not proposed a reasonable compromise.

Mr. Lamont asked if there were any truth in a rumour that the Company had lost money by speculations in rubber, and made money by speculations in tyre companies.

The **Chairman**, in reply, said the Company had not been speculating in rubber, and, therefore, had neither made nor lost money as a consequence, and the rest of the question was understood to be also answered negatively.

The resolution was put and carried, and the meeting was then made special to consider the following resolutions: "That articles of association 101, 102, and 103 be struck out and the following articles substituted: (101) At the ordinary meeting in every year the directors shall lay before the Company a profit and loss account and a balance-sheet containing a summary of the property and liabilities of the Company made up to a date not more than three months before the meeting. (102) Every such balance-sheet shall be accompanied by a report of the directors as to the state and condition of the Company and as to the amount which they recommend to be paid out of the profits by way of dividend or bonus to the members, and the amount (if any) which they propose to carry to the reserve fund, and the account, report, and balance-sheet shall be signed by a director and countersigned by the secretary. That in article of association 104, after the word 'such,' the words 'report, account, and' be inserted. That article of association 112 be struck out and the following article substituted: (112) A firm of chartered accountants may be appointed auditors, and any casual vacancy occurring in the office of auditor shall be filled up by the directors by nominating a chartered accountant or a firm of chartered accountants to be auditor or auditors until the next general meeting. That article of association 116 be struck out, and that there be added at the end of Article 114 'and to report to the Company in general meeting thereon.'" It was explained that the main alteration was at the request of the auditor, Mr. J. F. Clarke the wording of the original article being inconvenient and old-fashioned. Mr. Clarke was not present, and a very large amount of conversation followed. It was suggested that the articles to be altered as well as the proposed new ones should be printed and circulated among the shareholders, and **Mr. Cochrane** proposed and **Mr. Lamont** seconded an adjournment of a month to allow this to be done. This was not seriously opposed by the Board, but much discussion ensued as to the date, as it was considered inconvenient to hold a meeting in August or September. Ultimately the 21st inst. was fixed for the date, and the meeting was, with one dissentient, adjourned to then.

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CONSOLIDATED TELEPHONE CONSTRUCTION AND MANUFACTURING COMPANY.

The directors, in their report for the year ended March 31 last, state that the accounts nominally represent one year's trading; in reality, owing to the suspension necessary in removing the works and offices, a period of about nine months only is covered. The total receipts for the year on revenue account amount to £6,614, including £3,209 received in respect of the Edison Gower-Bell Telephone Company of Europe, Limited, Belgian lawsuit, and £1,750 transferred from revenue suspense account, being dividend declared payable on July 1, 1896, by the Edison Gower-Bell Telephone Company of Europe, Limited. Deducting the usual expenses, amounting to £1,991, this will leave a balance of £4,622, against which the directors have decided to write off various items, amounting in all to £1,821, and to reserve the sum of £1,025 against loans. This will leave a net sum available of £3,023, out of which the directors propose to pay a dividend of £1. 10s. per cent., carrying a balance forward of £1,393. The competition in the manufacturing business continues very keen. The lease of the factory and offices at Farringdon-road having expired at Christmas last, the directors, after much search in the Midlands, decided upon the purchase of some works (freehold) at Coventry at an advantageous price. There is a considerable area of ground capable of being built upon in the event of extension of manufacturing business. The saving in labour, fuel, rent, and taxes promises to be favourable, and though the boom in the bicycle trade has somewhat interfered with expectations under the first item, matters are satisfactorily settling down. Offices, etc., in London, have also been obtained upon satisfactory terms, and the directors propose that the subsidiary companies shall be asked to remove to the same building as soon as convenient. The lawsuit in Belgium carried on by the Edison Gower-Bell Telephone Company of Europe has had a satisfactory termination as regards certain of the infringing companies, and a large sum of money has been paid in respect of damages. Further vigorous action has been commenced against the other infringing companies. The subsidiary company, the Anglo-Portuguese Telephone Company, continues to show satisfactory progress.

The fifteenth annual meeting was held yesterday (Thursday) at Winchester House, the Chairman of the Company (Mr. C. L. W. FitzGerald) presiding.

The **Chairman**, in moving the adoption of the report, said he could not disguise from them that this year their profit on trading had really reached its lowest limits. This was caused, he thought, by three things. First and most important of all was the decrease in the sale value, and that meant, as he had told them year by year, that their wages kept up while the sale value of the things they had to sell kept on decreasing. That was caused by the very severe competition that there was in the telephone world. Another serious cause of the decrease was the fact of their having moved the factory from London to Coventry, which put them to very great inconvenience in turning out the orders. They had been very busy for the last three months and were now, so that he hoped that if this improvement continued that they would have a better balance-sheet to show next year. Two shareholders had written suggesting that the Company ought to go into liquidation, but this question was fully discussed at the last meeting, when they decided to move to Coventry. He proposed that a dividend of 1½ per cent. should be declared.

This was seconded.

A long discussion took place on the balance-sheet, several shareholders pointing out the absurdity of a capital of £112,000 earning a profit of only £127, while the directors' fees, salaries, office expenses, and other fees and expenses amounted to over £1,800.

The **Chairman**, however, replied that they moved to Coventry because they were not doing well in London, and therefore, taking everything into consideration, they did not expect a large profit. As he had said, things had shown signs of improvement, and he hoped they would be in a much better condition at the next annual meeting.

The resolution was carried unanimously, and the other business was purely formal.

ELECTRIC POWER STORAGE COMPANY, LIMITED.

Directors: John Irving Courtenay, Esq. (chairman and managing director); Sir Daniel Cooper, Bart., G.C.M.G.; Frederick Green, Esq.; James Pender, Esq., M.P. Manager: Frank King, M.I E.E. Secretary: J. W. Barnard.

Report of the directors to be presented to the shareholders at the seventh ordinary general meeting to be held on July 16, at the offices of the Company, 4, Great Winchester-street, E.C., at 2.30 p.m.:

The net profit for the year is £4,416. 5s. 3d, which, with a balance of £170. 18s. 2d. from last year, amounts to £4,587. 3s. 5d, out of which the directors recommend the payment of a dividend of 5 per cent. on the ordinary share capital, which will absorb £4,243. 3s. 10d., leaving £343 19s. 7d. to be carried forward. Provision has been made for the maintenance of buildings plant, tools, etc., at a cost of £2,272. 16s. 8d. The quantity of the Company's manufactures sold during the past year shows a satisfactory increase. The Company has acquired, after long and exhaustive experiment, the patents for the United Kingdom and an interest in certain foreign patents covering a new storage cell, in which considerable reduction in weight and space is obtained without increase of cost. The retiring director is Sir Daniel Cooper, Bart., G.C.M.G., who offers himself for re-election. The auditors, Messrs. James Meston and Co., chartered accountants, also offer themselves for re-election.

PROFIT AND LOSS ACCOUNT, YEAR ENDING MAY 30, 1896.

Dr.	£	s.	d.
Rents, taxes, licenses, etc.	3,487	12	8
General expenses, management, directors' fees, etc.	5,796	12	11
Advertising, insurances, and travelling expenses, etc.	2,661	15	8
Patent fees and charges and law expenses	693	12	6
Maintenance of buildings, plant, and tools, etc.	1,979	17	10
Depreciation written off plant, tools, etc.	292	18	10
Auditors' fees	60	0	0
Balance, being net profit carried to balance sheet	4,416	5	3
	£19,388	15	8

Cr.	£	s.	d.
Balance from trading account (after deducting discounts and all allowances)	19,108	7	0
Interest on investments, etc.	280	8	8
	£19,388	15	8

BALANCE-SHEET, MAY 30, 1896.

Liabilities.	£	s.	d.
Share capital authorised—20,100 shares of £5 each, of which 100 are founders' shares	100,500	0	0
Shares issued 66 founders' shares of £5 each, fully paid (exclusive of four shares forfeited)	330	0	0
15,120 ordinary shares of £5 each, fully paid	75,600	0	0
3,137 ditto of £5 each, £3 called (exclusive of 400 shares forfeited)	9,411	0	0
18 323	85,341	0	0
Deduct calls in arrears	122	12	8
	85,218	7	4
Sundry creditors	14,358	12	3
Bills payable	5,000	0	0
Reserve fund	12,000	0	0
Balance at credit of profit and loss account May 31, 1895, after paying dividend at 5 per cent., £170. 18s 2d.; add profit for year 1895-6, £4,416. 5s. 3d.	4,587	3	5
	£121,164	3	0

Assets.	£	s.	d.
Patents, etc., as per last balance-sheet	76,360	0	0
Additions during year	9,400	0	0
	85,760	0	0
Plant, tools, furniture, fixtures and fittings (including £371. 7s. 1d. for plant, etc., added this year), £2,929. 8s. 6d., less depreciation written off this year, £292. 18s. 10d.	2,636	9	8
Stock on hand—at cost or under	11,907	10	9
Sundry debtors (less reserve for discounts and doubtful debts)	12,470	14	4
Bills receivable	930	5	0
Investments in Government stocks, debentures, etc.	5,617	16	0
Cash—at bankers £1,769. 1s. 2d., in hand £72. 6s. 1d.	1,841	7	3
	£121,164	3	0

UNITED RIVER PLATE TELEPHONE COMPANY, LIMITED.

The report of the directors of this Company for the year ending March 31 last states that the receipts and expenses have been taken at the actual sterling value each month, thus obviating the necessity for the item loss on exchange, which has appeared in the accounts in past years. The gross receipts in sterling for the year in the River Plate were £48,744, as against £36,673 for the year before, and the working expenses in the River Plate £24 967, as against £17,558, leaving a profit, after the deduction of debenture interest and all London charges, of £14,505 as against £9,902, to which has to be added £4,619 brought forward from the previous year, making a total of £19,124. Out of this sum the directors propose to transfer £3,000 to depreciation and renewal fund, and recommend that a dividend of 4 per cent. (free of income tax) be paid upon the ordinary share capital of the Company, and that the balance o £4,524 be carried forward. The capital outlay was £2,682, as against £2,662 last year. There is every prospect that the improvement in the business of the Company will continue. The shareholders' meeting is fixed for next Tuesday at Winchester House.

Crewe.—The Corporation invite schemes and tenders (*a*) for erection of a refuse furnace and boiler upon land adjoining the site of their isolation hospital; (*b*) supply and erection of an engine and dynamo, laying of electric lighting mains, and placing a complete electric lighting installation in the hospital buildings; (*c*) supply of accumulators, sufficient for the electric lighting installation. Particulars of instructions may be obtained from Mr. Fredk. Cooke, town clerk, Municipal Offices, Earle-street, Crewe, to whom sealed tenders should be sent before 10 a.m. on 14th inst.

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CONTRACTS FOR ELECTRICAL SUPPLIES

CONTRACTS OPEN.

Bucharest.—Tenders will be received up to August 8 by the Roumanian Government (Department of Posts and Telegraphs) for the electric lighting of the new Posts and Telegraph building at Bucharest.

Spandau.—Tenders are wanted at the Royal Small-Arms Factory for 900 incandescent electric lamps by July 17. Particulars are obtainable for 75pfg. (9d.) from Die Königl. Direktion der Gewehrfabrik (Geschäftszimmer No. 21), Spandau.

Amsterdam.—Tenders will be received up to 21st inst. by the Engineering Department, Plantage Lijnbaansgracht, Amsterdam, for work in connection with the establishment of telegraphic and telephonic lines. The amount is slightly under £2,000.

Rheinbach (Germany).—Tenders are wanted by the Municipal Authorities of Rheinbach for various machinery for the waterworks and electric light supply, including boilers, engines, a dynamo, and storage battery. The date for tendering is 15th inst.

Simla (India).—The Municipality is inviting tenders for lighting by electric light for a term of years the principal thoroughfares and buildings belonging to the Municipality. Tenders must be submitted by September 1 next. Should any proposal be accepted, the Municipality will afford the successful tenderer all facilities to extend the system of lighting to private houses.

Cologne.—Tenders are required by the Municipal Authorities for the construction and working of electric tramways in the city of Cologne to an aggregate length of 20·3 kilometres (12½ miles). Specifications, plans, and particulars are obtainable for 10 marks (10s.) from der Registrateur B, des Oberbürgermeisteramt, Köln, Germany, and tenders must be in by November 6.

Madras.—Tenders are invited for the lighting by electricity of Government House, Madras, including the banqueting-hall and aide-de-camps' bungalow, and also for the lighting of Government House, Guindy, including the military secretary's bungalow. For particulars application must be made to the consulting architect to the Government, Chepank, Madras. Tenders will be opened on November 11, 1896.

London, W.—Tenders are required for the supply of (1) coal to the electric lighting station, South Ealing; and (2) coal and coke to the other depôt of the Urban District Council. Printed forms of tender, conditions of contract, etc,, and any further particulars can be obtained on application to Mr. C. Jones, C.E., surveyor to the Council, between 10 and 4. Tenders, in envelopes provided, to be delivered by 4 p.m. on 16th inst.

Lisbon.—The Royal Portuguese Railway Company want tenders by July 22 for the supply of 10,000 porcelain insulators with galvanised iron supports, 200 sheets of asbestos (1 metre square by 2 millimetres thick), and about 2½ tons of galvanised iron wire. The tenders are to be addressed to the Chief of the Stores Department at Santa Apolonia Station, Lisbon and particulars can also be obtained at Paris, Rue de Châteaudun 28.

Voghera (Italy).—In view of the expiration of their contract with the local gas company in 1898, the municipal authorities of Voghera are desirous of receiving during the present year propositions for the lighting of the town either by the electric light or a mixed system of gas and electricity. The population is 16,000. Application should be made to L'Administrazione Comunale, Voghera, who will give all particulars necessary.

Battersea (London).—The St. Mary's Vestry will receive tenders up to July 14 for a complete installation of the electric light for the town hall and municipal buildings. Specifications and conditions can be obtained from Mr. R. Hammond, Ormond House, Great Trinity-lane, E C., after a deposit of two guineas has been made with the Vestry Clerk, at the Vestry Offices, Lavender-hill, S.W. Clauses for the payment of trades union wages will be embodied in the contract.

Mexico.—The municipal authorities of the city of Mexico are prepared to receive proposals for the street lighting by incandescent lamps for a period of eight years. Tenders should be sent in by August 31. The Secretary of State for Foreign Affairs has received from the British Consul at Mexico a pamphlet issued by the Municipal Council of the city containing particulars as to the tenders, and this may be seen on application to the Commercial Department of the Foreign Office between the hours of 11 and 6.

London.—The Vestry of St. Pancras invite tenders for the supply of Welsh and other steam coal for use at the Regent's Park and the King's-road central stations for 12 months from August 1. Delivery to be made as required; average about 100 tons per week. Copies of the specification, conditions of contract, and form of tender to be obtained upon application at the electricity department offices, 57, Pratt-street, N.W., on payment of a deposit of 5s. Tenders to be sent to Mr. C. H. F. Barrett, vestry clerk, Vestry Hall, Pancras-road, endorsed "Tender for Coal," by 12 noon on 16th inst.

Bedford.—Tenders are invited by the Urban Sanitary Authority for supply of steam coal to the electricity works, for one year ending July 23, 1897. The coal to be one of the following kinds: Annesley hard coal, Pilsley ditto, Linby ditto, or from some other approved colliery. Sealed tenders, endorsed "Tenders for Coal," to be sent to Mr. T. S. Porter, clerk, Town Hall, Bedford, by 14th inst., with samples of the coal proposed to be supplied. Every tender must be in a printed form, a copy of which may be obtained at the clerk's office. The person whose tender is accepted will be required to furnish the colliery certificate.

San Juan (Puerto Rico).—H.M. Secretary of State for Foreign Affairs has received from H.M. ambassador at Madrid a copy of a Spanish Royal Order which has appeared in the *Gazette* inviting tenders for the construction and working of a telephone system in San Juan de Puerto Rico. A deposit of 800dol. must accompany each tender. which will be considered on August 10. The copy of the Royal Order may be seen on application to the Commercial Department of the Foreign Office between the hours of 11 and 6.

Hull.—Tenders are required by the Electric Lighting Committee for the supply of best South Yorkshire hard steam doubled-screened nuts for 12 months ending June 31, 1897, in accordance with the conditions set forth in the form of tender, which may be obtained at the Electric Lighting Offices, Dagger-lane. The contractor will have to enter into the usual form of contract required by the Corporation. Tenders, endorsed "Double-Screened Nuts for Electric Lighting Station," to be sent, under seal, to the chairman of the Electric Lighting Committee, Town Hall, by noon on 30th inst. Mr A. S. Barnard, borough electrical engineer, Electric Lighting Station, Dagger-lane.

Edinburgh. Tenders are invited for the works in proposed additions and alterations to the central electric lighting station at Torphichen street, consisting of foundations and settings for engines, boilers, etc, new upper flat over boiler-house, and other relative works, for the Magistrates and Council. Plans, specifications, and general conditions of contract may be seen at the office of the Burgh Engineer, 1, Parliament-square, from whom schedules of quantities and forms of tender may be obtained on deposit of £1. 1s., which will be returned on receipt of a bona fide tender. Sealed tenders, endorsed "Tender. "Additions and Alterations, Central Electric Lighting Station Edinburgh," to be lodged with the burgh engineer by 10 a.m. on 13th inst.

Wallasey.—For condensing apparatus and steam and exhaust pipes in connection with their electric light installation, tenders are invited by the Wallasey Urban District Council. Drawings may be seen, and copy of the specification obtained, on application to the engineer, Mr. J. H. Crowther, at the Gas and Waterworks, Great Float, near Birkenhead, on payment of £2. 2s., to be returned on receipt of a bona fide tender. Sealed tenders, on the form provided, addressed to the chairman of the Gas and Water Committee, and endorsed "Tender for Condensing Apparatus, etc.," to be delivered at the office of Mr. W. Danger, clerk to the Council, Public Offices, Egremont, Cheshire, by 4 p.m. on July 16 The contractor will be required to enter into a bond, with approved sureties, for the due performance of the contract.

Army Contracts.—The Secretary of State for War gives notice that tenders for specific quantities of the following articles will probably be invited from time to time during the next twelve months — namely: submarine mining electrical instruments, telegraph cable and wire, etc. Manufacturers who may wish to be applied to when tenders are required should address the Director of Army Contracts, War Office, Pall-mall, S.W., by letter, stating the particular articles which they manufacture, and the names of at least two well-known firms or public bodies who have purchased from them, and are in a position to certify as to the quality of their productions. Applications unaccompanied by references will not be noticed. Firms whose names are already on the War Office list need not apply, as forms for tendering will be sent to them in due course.

Egremont (Cheshire).—Tenders are invited by the Wallasey Urban District Council for the erection of an additional six-celled Fryer's patent refuse destructor, with Boulnois and Brodie's patent charging apparatus, Jones's fume cremator, steam-engine, and mortar mills, together with additional roofing buildings and electric lighting in connection with the existing refuse destructor works at Gorsey-lane, Poulton. Plans may be seen and specifications and forms of tender obtained on payment of £2. 2s, which will be returned on receipt of a bona fide tender, at the offices of the engineer and surveyor, Mr. Arthur Salmon, A.M.I.C.E. Separate sealed tenders, addressed to the chairman of the Health Committee, and endorsed "Destructor Contract D, E, F, or G," as the case may be, to be left at the office of Mr. W. Danger, clerk, Public Offices, Egremont, by 5 p m. on 20th inst. The contractor will be required to enter into a bond, with approved sureties, for the performance of contract, which contract and bond will be prepared at the expense of the contractor.

Kingston (Jamaica).—The Colonial Government invite electric tramway contractors willing to undertake the establishment and working of a system of rapid transit to send in applications for the grant of a license by the Governor in Privy Council under the Tramways Law, 1895. In all applications the principal questions to which attention should be directed are the following: (*a*) the amount of capital which the applicants are prepared to subscribe; (*b*) the system which it is proposed to establish; (*c*) the mileage of lines to be laid; (*d*) the fares to be charged; (*e*) the frequency of the service; (*f*) the length of the license required by applicants; (*g*) the guarantee which the applicants offer for the satisfactory performance on their part of any obligations devolving on them. Plans of the city of Kingston and part of the parish of St. Andrew, showing the routes on which the present tramway lines are laid, and copies of the law under which licenses are granted and of the rules made thereunder by the Governor in Privy Council, may be seen at the office of the Crown Agents for the Colonies, Downing-street, London, S.W. All applications must be delivered not later than July 31, 1896, in a sealed packet, marked on the outside "Application for Tramway License," to the clerk of the Privy Council, Kingston, Jamaica. Kingston has its principal means of transit at present supplied by the Jamaica Street Car Company by horse tramcars, the entire length of lines laid being about

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12 miles. The concession granted by the Legislature of the island to the Jamaica Street Car Company will shortly expire.

RESULTS OF TENDERS.

Bristol.—The Docks Committee have accepted the tender of Messrs. King, Mendham, and Co., of Bristol, for the electric lighting of the chill-rooms at the foreign animals wharf, Cumberland Basin.

Wakefield.—The West Riding County Council have accepted Messrs. Harding and Turton's tender for wiring in connection with the electric lighting of the county hall. The amount was £1,527. 10s.

Paisley.—The Corporation have accepted the tender of the Brush Electrical Engineering Company, Limited, to wire the George A. Clark Town Hall for the sum of £844, and also to supply an engine for the installation at a cost of £565.

Brussels. - For the materials and work in connection with the installation of the electric light at the Malines locomotive works the successful tenderers were the Compagnie internationale de l'electricité, Liège, at 7,403fr. There were nine tenders. No English firm tendered.

Rochdale.—For the electric lighting plant required at the free public library, consisting of gas-engine, dynamo, wiring, and fittings, for the Free Library Committee (Mr. S. S. Platt, A.M.I.C.E., borough surveyor), the tender of Messrs. Fletcher, Hirst, and Co , Burnley, was accepted.

Paris.—At the Postal and Telegraphic Department of the French Government, on June 25, contracts were awarded for 125 metric tons of galvanised-iron wire (three millimetres) to the Société de Commentry-Fourchambault, at 229·40fr.; and for 3,000 iron cross-pieces, with accessories, to the Forges de Franche Comté, Besançon, at 11,640fr. The contract for a million screws was not awarded, the lowest tender being 28,750fr., nor were the two other contracts for accessories.

London, N.W.—The following tenders were received by the Vestry of St. John, Hampstead, for the extension of the electric lighting station in the parish stoneyard, Lithos-road, Finchley-road, N.W. :

A. J. Chessum and Sons, Crown Works, Haggerston (accepted)	£7,499
J. Simpson and Son, 48, Paddington-street W.	7,551
Scharien and Co., Trafalgar square, Chelsea	7,583
R A. Yerbury and Sons, Birchington-road, Kilburn	7,600
R. Ballard, Limited, Child's Hill, N.W.	8 995

Leeds.—The City Council received the following tenders for an electrical installation sufficient for the working, by the overhead system of haulage, a double track of tramway seven miles long :

J. Russell and Sons, poles and brackets	£3,607	0	0
Greenwood and Batley, underground conduits and conductors	4,553	1	3
Crompton and Co., trolley wires and attachments (withdrawn)	3 370	0	0
Greenwood and Batley, electric motorcars	14,000	0	0
Chloride Electrical Storage Syndicate, accumulators and switches	1,341	0	0
Greenwood and Batley, steam-engines	3,507	0	0
Greenwood and Batley, dynamos, etc.	3,200	0	0
Clayton, Son, and Co., boilers, etc.	1,371	0	0
J. T. Wright, generating station	5,815	0	0

BUSINESS NOTES.

Direct Spanish Telegraph Company.—For the month of June the receipts were £1,960.

Western and Brazilian Telegraph Company.—For the past week the receipts were £2,855.

Boston (Lincs.).—The Town Council are considering the advisability of erecting an electric light installation for the town and the dock.

Rangoon (India).—The new Government House is lighted by electricity. The Jubilee Hall is also to be lighted by the same means.

Globe Telegraph and Trust Company.—The directors recommend a dividend of 3s. 9d. per share, leaving about £1 000 to be carried forward.

Peterborough.—The Local Government Board have refused to sanction the loan by the Town Council of £20,000 for electric lighting purposes.

Birkenhead.—It was stated at the last meeting of the Town Council that the electric light would be ready for consumers, it was hoped, in August.

Derry.—The Lighting Committee of the Corporation have decided to shift the electric lamps in the Diamond nearer to the School of Art, at a cost of £7. 10s.

Richmond (Yorks).—It is stated that the Castle Mill is to be used for electric lighting The question is before a select committee for consideration.

Wrexham.—The Town Council have decided to apply to the Board of Trade for a provisional order for the purpose of supplying electric light for the borough.

West India and Panama Telegraph Company.—For the two weeks ended June 30 the receipts were £2,382, as against £1,863 for the corresponding period of 1895.

Great Northern Telegraph Company.—For the month of April the receipts were £25,600

Oldham.—The Town Council have decided to make application to borrow a further sum of £10,000 in connection with the proposed extension of the electric lighting scheme.

British Incandescent Electric Lamp Company, Limited.—This Company has been formed, with a capital of £10,000, to carry on business as electrical engineers and electricians.

City and South London Railway.—The returns for the week ended July 5 were £881, compared with £915 for the corresponding period of last year, being a decrease of £34.

Belfast.—A largely-attended meeting of Belfast telegraphists, presided over by Mr. T. J. Wilson, has been held at the Artisans' Hall. The object of the meeting was with regard to their rate of wage.

Antimony-Gold and Complex Ores Extraction Company.—This Company has been formed, with a capital of £350,000 in £1 shares, and the present issue is 50,000, at premium of 10s. per share.

Hull.—The proposal of the Finance Committee to spend £40,000 on an additional electric lighting undertaking will, it is understood, come up as first business at the next meeting of the Town Council.

Helensburgh—At a meeting of the Police Commission it was agreed, on the recommendation of the special committee, to abandon the scheme for lighting the burgh by electricity, as the cost was too great.

Chamounix.—The Municipal Council have just voted a sum of 100,000f. with the object of introducing the electric light. It is expected that this part of Mont Blanc will receive the new illuminant next summer.

Brighton.—The Brighton and Rottingdean Electric Tramroad Act has received the Royal assent. Clifton Cricket Club and the Electric Cricket Club met in Preston Park last Saturday, and the former won by 87 runs.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending July 5 amounted to £1,286, as compared with £1,250 in the corresponding week of the previous year, being an increase of £36.

Electricity in Mining.—The British Arsenic Mines, Limited, the Anglo-Mexican Colonisation and Trading Company, Limited, and the Barrow Salt Company, Limited, take power to construct electric works and to supply electricity.

Stafford.—At the meeting of the Town Council the Gas and Electricity Committee recommended that the electric cables should be extended along Martin-street to Eastgate-street, at a cost not exceeding £35. The report was adopted.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ending July 4 were £2,403. 6s., compared with £1,912. 8s. 1d. for the corresponding period of last year, being an increase of £490. 17s. 11d.

Earl's Court.—The latest addition to this resort of interest is a two-storeyed tower, which has a large electric reflecting lamp on the summit which will throw a 4,000,000-c.p. light, and will be visible at almost any point in the 12 mile radius.

Preston Electric Company, Limited.—This Company has been formed, with a capital of £3,000, to acquire the business of electrical and mechanical engineers, etc , as now carried on by G. W. Preston, and to develop and extend the same.

South Manchester Electric Supply Company, Limited.—This Company has been registered, with a capital of £5,000 in £1 shares, to carry on at Withington and elsewhere in the neighbourhood of Manchester the business of an electric supply company.

Lewisham.—The Blackheath and Greenwich District Electric Light Company have given notice of their intention to apply to the Board of Trade for a provisional order authorising the company to supply electricity for public or private purposes in the parish of Lewisham.

Simla. - *Indian Engineering* says that the electric light in this place has proved successful Still, it is doubtful whether it will be introduced throughout Simla. It will be an expensive undertaking, and people look apprehensively on changes that may increase the taxation.

Standard Dynamo and Motor Manufacturing Company, Limited.—This Company has been started, with a capital of £2 000, to acquire the business of electrical engineers, etc., as now and hitherto carried on by Thomas Preece and Co., at Bradford, Yorkshire, and to develop and extend the same.

Liverpool.—Liverpool has entered upon the experiment, which it has had in view for some years, of taking over its electric supply from the company which heretofore has had the franchise and privileges. The price the city pays is £400,000, and, according to Sir Frederick Bramwell, no better installation is to be found in the kingdom.

W. T. Henley's Telegraph Works.—The directors of W. T. Henley's Telegraph Works Company, Limited, have declared an interim dividend on the ordinary shares for the half-year ending June 30, at the rate of 6 per cent. per annum, free of income tax, and upon the preference shares at the rate of 7 per cent. per annum, less income tax, both payable on September 1.

New German Cable Company.—A new company has been formed at Cologne under the title of the "Deutsche Seetelegraphen-Gesellschaft" (the German Submarine Cable Company). The primary object of the Company is to lay a cable between Germany and Spain, and eventually to extend it to the United

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States. The present share capital amounts to 3,560,000 marks (£178,000).

East Grinstead Electric Lighting Company, Limited.—This Company has been registered, with a capital of £15,000, to carry on the business of an electric light company in the parishes of East Grinstead, Forest Row, and North Sussex, and in the parish of Longfield, Surrey. Registered office: Place Land Offices, London road, East Grinstead.

Edinburgh.—The National Telephone Company have removed their South Side exchange to 1A, Hill-place to obtain superior accommodation. A new switchboard has been introduced on the multiple system, which is fitted for 600 subscribers. A new testboard has also been introduced, and in a third room is erected a series of translaters, by which a message is carried from the local to the trunk wires.

Wimbledon.—At the meeting of the Urban District Council the Road Committee reported that they had received notice from the County of London Brush Electric Lighting Company, Limited, of their intention to apply for a provisional order as to lighting Wimbledon by electricity. The Clerk stated that the company would not be able to apply for powers until July in next year, and the Council could apply at the same time.

Chelmsford.—Messrs. Crompton and Co. Limited, have just completed the arrangements for their new premises on a very convenient site, nine acres in extent, about half a mile from the old works. Large contracts for the necessary ironwork and the erection of the buildings were let immediately on obtaining possession of the land, and the Great Eastern Railway at once commenced work on the necessary sidings.

Morley.—The town clerk reported at the meeting of the Town Council that June 24 was the last day for depositing objections to the Corporation's application for the granting of a license for carrying out an electric lighting scheme, but that no objections had been deposited. Compliance with the Electric Lighting Act and the proving of plans was completed, so that everything was now ready for the scheme being proceeded with.

Cheltenham.—At a meeting of the Town Council the scheme for an electric tramway to Cleeve-hill, some three miles out of the town, was explained by the chairman of the Streets Committee. Alderman Norman moved that the matter be referred back to the committee, the suggested route being unsuitable, in his opinion. This was agreed to. The discussion showed the promoters that the Corporation viewed the proposal with favour.

Calcutta.—Messrs. Kilburn and Co., of Calcutta, have applied to the local Government for permission, under the Electric Lighting Act of 1895, to supply electric light and power to Calcutta. It is understood that Messrs. Kilburn and Co. have come to an arrangement with the Calcutta Tramways Company to supply the motive power to work their cars with electricity. The system adopted will be the low-tension continuous-current system.

Warrington.—Notice having been received from the County of London and Brush Provincial Electric Lighting Company, Limited, of their intention to apply to the Board of Trade for a provisional order to supply electrical energy for public or private purposes within the area of the borough, the General Purposes Committee of the Town Council have resolved that the town clerk give notice to the Board of Trade objecting to such notice and to the issue of a provisional order.

Dublin.—At a meeting of the Judicial Committee of the Privy Council an application was heard on behalf of the Belfast Street Tramways Company for an Order in Council authorising the construction and maintenance by the Belfast Street Tramways Company of certain additional lines outside the city boundary, and for the purpose of doubling their existing lines on the Falls-road, Ormeau-road, Shore-road, and Lisburn-road. The order was sanctioned, subject to some alterations.

Aberdeen.—The county of Fife wishes Aberdeen to co-operate with them in endeavouring to get arrangements made for the use of the telephone system on such terms that the annual cost would place that system within the reach of all the counties. The County Council have decided to remit the communication to their delegates appointed to attend the meetings of the County Councils Association, with power to them to take such steps as they might think best in the interests of the county.

Merthyr.—The Bill confirming a provisional order granted by the Board of Trade to J. C. Howell, Limited, for the production and supply of electricity in respect of the urban district of Merthyr Tydfil has been before the examiner of the House of Lords for proof of compliance with the Standing Orders. The examiner found that there had been a non-compliance in respect of the lateness of certain notices, and the matter will come before the Standing Orders Committee in due course.

St. James's and Pall Mall Company.—The directors of the St. James's and Pall Mall Electric Light Company, Limited, have declared the following interim dividends for the half-year ending June 30: at the rate of 7 per cent. per annum on the preference shares, and at the rate of 5 per cent. per annum on the ordinary shares. The sale of electricity for the quarter ending June 24, representing the supply at 6d. per unit, amounted to £10,657 as against £8,598 at the same rate for the corresponding period of 1895.

Bilbao.—In Consul Smith's report on the trade of Bilbao, after remarking on the openings for business in electrical machinery and work in Spain, that official says: "If electrical plant manufacturers write and ask me for lists of firms to which they may send their price-lists, which are made out in English, I shall reply that a list of firms will be found in the *Libro de Bilbao*, published by Lavranga y Lejarcegui, calle de Ledesma 22, Bilbao." A shorter way of putting it would be to say, "Look in the directory." Consul Smith further recommends the sending out of travellers.

Bury.—At the meeting of the Town Council, a long report was read from the surveyor as to the tramways. It was stated that a sub-committee had come to the conclusion that there could be no objection to the overhead tramway system as in use at Bristol, and as proposed by the Bury and Rochdale Tramway Company; but that, in face of the expenditure in altering the mode of traction, obtaining special powers, etc., the sub-committee considered the present an inopportune time to discuss the terms for acquiring the tramways and leasing the company power to work them.

Salford.—At the meeting of the Town Council, Councillor Thompson asked the chairman of the Gas Committee if he could not see his way to propose the lighting of the public streets with the electric light instead of gas. In this way the shopkeepers would have an opportunity of getting the electric light cheaper than at present. Councillor Holland said he could not see his way to promise anything of the sort. If the shopkeepers would purchase the cheap electric light it would enable the committee to make further extensions, but he thought it was wiser to earn the working expenses first.

Wandsworth.—On Saturday last the men employed by the Brush Company on their Wandsworth contract had an excursion to Bognor. They left London Bridge by the 8 o'clock train. Dinner was served at the Beach Hotel, Mr. G. A. Cowles presiding in the unavoidable absence of Mr. P. J. Pringle, resident engineer, and several other members of the staff were present. At the conclusion of dinner a vote of thanks was heartily accorded the Brush Company and others for their donations. During the afternoon a large party went for a drive to Chichester and back, and a most enjoyable day was spent.

Metropolitan Asylums Board.—At the meeting of this Board the North-Western Hospital Committee reported that they had had under consideration the question of lighting by electricity the new building about to be erected for the staff, and had consulted Prof. Ayrton (the electrical engineer who superintended the installation of the electric light in the new administrative block, pavilions, etc.) upon the subject. Prof. Ayrton had agreed to prepare a specification and to supervise the carrying out of the work at fees of 10 and 35 guineas respectively. They therefore recommended that Prof. Ayrton be employed on these terms, and this was agreed to.

Fulham.—The Electric Lighting and Dust Destructor Committee of the Vestry have considered the report of Mr. F. H. Medhurst on refuse destructors and electric lighting, and recommend that a deputation be appointed consisting of the chairman, vice-chairman, and four members of the committee, with Mr. Medhurst (the electrical engineer), the medical officer of health, and the surveyor, to visit the towns of Leeds, Warrington, Oldham, Brighton, Bedford, and Portsmouth for the purpose of seeing the destructors in operation and inspecting the electricity supply works. In the meantime the surveyor is to make applications for particulars of the works in progress at the towns proposed to be visited.

Birmingham.—The City Council have decided by 33 votes to 23 to accept the offer of Messrs. Mackenzie and Ross, of Montreal, to take a lease for 21 years of the system of tramways at present worked by the Central Tramway Company, whose rights the syndicate have provisionally agreed to acquire. They are to pay an annual rent to the Corporation of £5 000, to substitute an improved form of traction, probably electrical, in place of the present steam traction, to concede ½d. fares, and to shorten the hours of the tramway employés. The leases of the present company expire in 11 years and the opponents of the syndicate advocate that at the end of that time the tramways should be taken over by the Corporation.

Paisley.—At a meeting of the Town Council it was reported by the Electric Lighting Committee that they had agreed to accept the offer of the Brush Electrical Engineering Company, Limited, to wire the George A. Clark Town Hall for the sum of £844. The work is to be done to the satisfaction of Dr. Bottomley or such other consulting electrical engineer as may during the period allowed for the completion of the work be appointed by the Town Council to superintend the same, as also to the satisfaction of any resident engineer who may be appointed by the Council. It was also reported that at a further meeting the committee had agreed to accept the tender of the Brush Company to supply an engine for the installation at a cost of £565.

Telephone Directory.—In consequence of the National Telephone Company's trunk wires having been transferred to the Government and the large development of the exchange system which is anticipated, the directors of the company have issued a telephone directory which contains the names, numbers, professions or trades, and addresses of all the company's subscribers throughout the United Kingdom. The directory is arranged in a most convenient form, and will be of very great convenience to all users of telephones. A complete index to towns is given, and also to all public call offices, and for the purpose of expediting messages in London the name of the exchange is given in addition to the subscriber's number. Specially-prepared cases for binding and hanging up can be obtained.

Appointments Vacant.—A chief electrical engineer is required for the English electricity works in Madrid. He must have had the management of similar works (alternating-current system), and be able to show first-class record. Commencing salary £500 per annum, with bonus on net profits, guaranteed to be not less than

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£130. Apply, in confidence, to the consulting engineer of the company, Mr. Robert Hammond, Ormond House, Great Trinity-lane, London, E.C., on or before 11th inst.—The Town Council of Salford require a mathematical lecturer, who must be qualified to assist in the physical and electrical engineering departments Salary £180 per annum. They also require an assistant lecturer and demonstrator in chemistry. Salary £70 per annum. Particulars of duties and forms of application may be obtained up to the 11th inst. from the secretary at the Royal Technical Institute.

The Metropolitan Electric Supply Company.—The directors have, in consequence of the large subscription, decided to receive no more applications for new shares except from existing shareholders of the Company. An issue was announced of 12,500 ordinary shares of £10 each at the price of £12 per share. The proceeds arising from the present issue will be expended on extensions of mains, on additions to machinery and plant, and on the formation of transformer sub-stations, whereby, it is stated, a considerable economy in working costs will be obtained. Further issues of the present capital will be made from time to time to keep pace with the development of the Company's business. It is stated that the gross revenue for the first quarter of the present year shows an increase of upwards of 23 per cent. over that for the corresponding quarter of 1895. The list closes at or before 4 p.m. to-day (Friday).

Wakefield.—The General Purposes Committee of the West Riding County Council have had under consideration the question of the electric light for the new county offices, and have had a special report prepared by Mr. Sidney à Court, London, upon the subject. The Wakefield Corporation will shortly be in a position to supply the electric light, but Mr. à Court is of opinion that very considerable economy, besides other advantages, would be secured by the County Council itself supplying electricity, and the committee will recommend the Council to lay down plant for generating electricity by steam, in combination with the heating system. The estimates are as follows: provision of plant for generating electricity by steam, in combination with the heating system, at an estimated cost of £995 for plant and £850 for storage battery; the wiring of the place in insulated iron tubes £1,450, instead of in wood casing for £800, as already provided in the estimates; and the providing of inter-telephonic communication, £270 The Council have adopted Mr. à Court's recommendations.

Torquay.—A public meeting of the burgesses has been held, convened by the mayor (Mr. Alderman Bovey) in response to a requisition signed by a number of the ratepayers and property owners of the borough, in view of the Local Government Board enquiry to be held to-day (Friday) consequent upon the application of the Town Council for sanction to borrow £22,300 for an installation of the electric light in the town. It was decided that in view of the existing indebtedness of the borough and of the inevitable further heavy expenditure the proposed installation of the electric light by the Town Council is premature, and should be deferred for the present. It was also resolved that an influential deputation be appointed to lay the above resolution before the Town Council, and also to bring it to the notice of the Local Government Board inspector at the enquiry. The resolution of the burgesses' meeting was brought before the Town Council, but it was decided not to discuss the matter, and the resolution was referred to the Electric Lighting Committee. The Ilford Electric Lighting Company have given notice of their intention to apply to Parliament for a provisional order for lighting the town with electricity.

River Plate Electric Light and Traction Company.—The River Plate Trust, Loan, and Agency Company are authorised by the River Plate Electric Light and Traction Company, Limited, to receive subscriptions for an issue by the latter company, at the price of 97½, of £125,000 5 per cent. debenture stock (part of an amount of £150,000 like stock authorised), redeemable by the company at six months' notice at 107½ interest being payable half-yearly. The prospectus points out that the stock will form a first charge on the whole of the Company's assets, the River Plate Trust and Agency being trustees for the debenture holders. It is stated that the Company's electric lighting stations are already in operation in the cities of the La Plata and Rosario and a station is in course of construction at Tucuman city. The additional capital is for the purpose of erecting a station in Buenos Ayres, the requisite authorisation having been obtained. The Company's authorised share capital is £300,000, in equal proportions of 6 per cent preference and ordinary £5 shares It is stated that the Company's revenues have increased, and it is estimated that the net results of the four stations will not fall short of £24,000. The list closes to-day (Friday)

Crewe.—At the meeting of the Town Council the sub-committee appointed to arrange details concerning the isolation hospital presented the following report, which was confirmed by the Council: "The sub-committee have had under consideration a proposal to place upon the hospital site, adjoining the laundry block, a boiler and furnaces of sufficient dimensions to supply steam for the laundry and the disinfector, and to drive an engine and dynamo for electric lighting purposes, the furnaces to be of a type constructed to burn unscreened ashpit refuse, of which 10 tons daily are available within half a mile of the site. Definite tenders for such a boiler and furnaces have been before the committee, and information has been obtained as to the cost of electric lighting plant, from which it appears that the cost of the boiler and furnaces would be £400, and the electric lighting plant and installation £418, making a total of £818. The power available for the furnaces would be sufficient to supply electric lighting to a small area surrounding the site, which there seems at present some difficulty in lighting with gas. The committee are satisfied from enquiries made, and from actual inspection of the plant elsewhere, that the proposals made can be carried out without entailing any nuisance or discomfort upon the occupants of the buildings adjoining."

Glasgow.—The report of the Tramway Sub-Committee contains the following estimate by Mr. Clark of the cost of the test route between Kelvinside and Dennistoun: "The route from Kelvinside to Dennistoun measures 4½ miles of double track. The power-house, generating plant, feeders, and motorcars would be practically the same whether the conversion were to an overhead or conduit system. In either case I estimate the cost of these, based upon a two minutes' service, would approximately be: power-house, exclusive of ground, £6,000; generating plant, £16,250; feeders for 4½ miles double track, at £1,668 per mile, £7,089; 45 new motorcars, at £550 each, £24,750—total, £54,089. For a test of the overhead system I take it that where the rails do not require renewal the existing track would remain undisturbed, excepting for the bonding of the rails; and for the overhead construction there would be iron tubular poles to carry the cross span wires where there are no buildings, and that where there are buildings the cross span wires would be fixed to them by ornamental rosettes, as at Hamburg, Milan, Coventry, and other towns. In that case I estimate the cost of overhead construction and rail bonding would be: 4½ miles double track at £1,212. 7s. per mile, £5,902 10s.; about two miles of the track would require relaying with new rails, and the stones redressed and relaid with requisite proportion of new stones, for this add, say, two miles at £4,706 per mile, £9,412—total for 4½ miles, £15,314. 10s."

Ealing.—Colonel W. M. Ducat, R.E, has held an enquiry concerning the District Council's application to the Local Government Board for permission to borrow £23,200 for electric lighting purposes. The Clerk (Mr. W Ruston) explained that a year or two ago the Local Government Board sanctioned a loan of £25,000 for electric lighting purposes, and in March last year sanctioned another loan of £7,000 for the same purpose. The original scheme was for the public lighting of the main roads, and for the supply of 5,000 private 8 c p. lamps. It was estimated that that number would be sufficient for the first three years, but so great had been the demand that at the present time—only 21 months after the works were opened—6,474 private lamps had already been connected, and the applications totalled to 9,000 lamps. In these circumstances, the Council had been compelled to make various extensions beyond the compulsory area, and it had been found economical to use electric light instead of gas in the streets through which the mains had been taken. He had, therefore, to ask the sanction of the Local Government Board to new electric lighting loans of £9,000, £6,000, £2,200, and £6,000, which would raise the total sum borrowed to £55,000. The Council asked that the repayment of the loans should extend over 30 years, or as long as the Board would grant In answer to the Inspector, the Clerk stated that the total amount actually expended, or for which the Council was liable, was £42,000. Replying to a further question Mr. Harris, consulting electrical engineer, said that the revenue of the Council from electric lighting from April 1, 1895, to March 31 last was £3,000. It was practically certain that this year the revenue would be £1,000 more.

Salisbury.—At the meeting of the Town Council the Town Clerk informed the meeting that he had received a copy of correspondence which had passed between the promoters of this company and the Board of Trade, and a request from the latter authority that the Council would transmit to the Board of Trade any observations they wished to make thereon. It appeared that the Board of Trade had written to the secretary of the Salisbury Electric Light and Supply Company, in a letter dated the 3rd ult., intimating, in reference to the Salisbury Electric Lighting Order, 1895, that as the undertakers had failed to comply with the provisions of Section 7 of that order it devolved upon the Board to consider whether they should not revoke the order. To this Mr. W. H. Gramshaw wrote, in reply, stating that the delay had arisen from several unfortunate circumstances which he had explained in a personal interview. He added: "We have, however, now made arrangements for carrying out the works. The contract will be for £14,000, of which the contractors take £7,000 in debentures. I can undertake the placing of £3,000 leaving a comparatively small sum to be subscribed. Under the circumstances we hope the Board of Trade will not proceed to revoke the order, but will give us such extension as they may think fit. We should suggest that the fulfilment of the obligations under Section 7 should be extended for a period of three months from the 1st June, 1896." In a further letter the Board of Trade replied that, subject to the concurrence of the local authority, whom they proposed to consult, they were prepared to defer the consideration of the question of the revocation of the order for a period of three months from the 1st inst. The Town Clerk said the Board of Trade wished to know whether the Council assented to the postponement of the question until September 1. The meeting gave its unanimous concurrence to the proposal.

Manchester.—Mr. Rienzi Walton, Local Government Board inspector, has held an enquiry into an application by the Corporation for power to borrow £100,000 for purposes of electric lighting. Mr. Alderman Higginbottom, chairman of the Electric Light Sub-Committee of the Gas Committee, stated that the electric works were originally laid down by Dr. John Hopkinson, and the system in use was the five-wire direct-current continuous under the Westinghouse patents All the later extensions had been carried out by the present resident engineer, Mr. Wordingham. The total money borrowed up to date was £250,000, and the whole of it had been expended in the construction of various works and machinery

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and mains, in accordance with the details given at former enquiries. The demand for the electric current had been so great and was continuing at such a great rate that it was absolutely necessary to increase the plant and mains to meet the further demand. In 1893 the number of consumers was 82, and in June, 1896, it had increased to 1,216 The number of lamps in 1893 was 8,000, and in June, 1896, it had reached 109,636. About 7,100 lamps were still waiting connection, which would bring up the total to 116,700 lamps Even with the proposed extensions the capacity of the electric station was only equal to 136,000 lamps, so that only 19,300 lamps had to be added in order to exhaust the capacity of the present works. The Board of Trade had just given their consent to the area of supply being extended to the whole area of the city of Manchester, a distance of 7¼ miles from north to south, and of five miles from east to west, or an area of 20¼ square miles. It was quite evident that at an early date large extensions, or else a new station upon another site, would have to be begun to cope with the ever-growing demand for electric current for lighting, motive, and other purposes. The works from a financial point of view, had been a great success. Mr. C. H. Wordingham, chief electrical engineer to the Corporation, also gave evidence.

PROVISIONAL PATENTS, 1896.

JUNE 29.

14317. Improvements in electric tramways. James Enright, 202, Holland-road, Kensington, London.

14331. Improvements in and connected with electric tramways or railways. Andrew George Adamson, 154 St. Vincent-street, Glasgow.

14332. Improvements in apparatus for the use of electric light, gas, or oil for photographic, illuminating, and other purposes. Andrew George Adamson, 154, St. Vincent-street, Glasgow.

14367. An improvement in electro-deposition of metals and metallic alloys. Charles Arthur Hales, 19, Canonbury-villas, Canonbury, London.

14370. Improvements in electric arc lamps. Alfred Klotz, 18, Buckingham street, Strand, London

14376. Improvements in master clocks for operating or controlling circuits of electrical dials and similar instruments. George Bennett Bowell, 322, High Holborn, London.

14393. Improvements in anodes for electrolytic purposes. Peter Jensen, 77, Chancery-lane, London. (Henrik Christian Fredrik Störmer, Norway.)

14397. Improvements in electric arc lamps. Frederik Vilhelm Andersen, 40, Chancery-lane, London.

JUNE 30.

14442. Improvements in and relating to telegraphy. Samuel Van Buren Essick, 55, Chancery-lane, London. (Complete specification.)

14462. Improvements in or relating to systems of electrical distribution. Alfred Julius Boult, 111, Hatton-garden, London. (Gordon John Scott and William Smith Janney, United States.) (Complete specification.)

14463. Improvements in telegraphic alphabets. Samuel Van Buren Essick, 40, Chancery lane London. (Complete specification.)

14464. Improvements in telegraphy. Samuel Van Buren Essick, 40, Chancery-lane, London. (Complete specification.)

14500. An improved call counter suitable for telephone exchanges. Franz Stock, 18, Buckingham-street, Strand, London. (Complete specification.)

JULY 1.

14551. Securing so-called "caps" or "collars" to the necks of incandescent electric lamp globes. Francis Harrison and Isaac Probert, 25, Union-road, Clapham, London.

14554. A buoy that can be sunk or raised electrically from a distance. Siemens Bros. and Co., Limited, 28, Southampton-buildings, Chancery-lane, London. (Siemens and Halske, Germany.)

14555. Improvements in the process and apparatus for the papering of iron sheets for electrical and magnetical apparatus. Siemens Bros. and Co., Limited, 28, Southampton-buildings, Chancery-lane, London. (Siemens and Halske, Germany)

14584. Improvement in or connected with the arrangement and attachments of electrolytic anodes. Pierre Eugène Secrétan, 6, Lord-street, Liverpool.

JULY 2.

14613. Improvements in telephonic transmitters. Alexander Marr, 70, Market-street, Manchester.

14639. Improvements in apparatus for the production of electricity from the waste heat of gas, steam, or other heat engines. Herbert John Dowsing, 24, Budge row, London.

14641. Improvements in electric gas lighters. Gustav Byng, 73, St. Stephen's-road, Upton Park, London.

14642. Improvements in and connected with electric bells, gongs, and the like. Max Byng and Francis George Bell, 73, St. Stephen's-road, Upton Park, London.

JULY 3.

14766. Improvements in or relating to sockets or holders for incandescent electric lamps, and the attachment of lamps thereto. Eduard Worringen, of the Firm Constantia Incandescent Lamp Manufactory, 111, Hatton-garden, London.

JULY 4.

14846. Improvements in conducting contacts with carbon or other non-metallic electrodes. Siemens Bros. and Co., Limited, and Dr. Eugen Obach, 28, Southampton buildings, Chancery-lane, London (Complete specification.)

14848. Improvements in or connected with electric induction coils and transformers. Alfred Apps, 433, Strand, London.

14872. Improvements in telephone exchanges. Salomon Berditschewsky-Apostoloff, 53, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1891.

5167. Making tubes by electrolysis. F. E. and A S. Elmore. (Second edition.)

1892.

14181. Electric batteries. Shrewsbury and Dobell. (Second edition.)

1895.

11498. Electric, etc., railways. Sayer.

11817. Measuring electric currents, etc. Campbell.

11944. Electrolytic deposition of metals. Raleigh.

13459. Electric cables or conductors. Heyl.

14403. Electrical gas igniting devices. Jahnsson.

15134. Covering electric, etc., wires. Washington.

19204. Electric signalling. Gibson (Amended specification.)

1896.

5506. Electric accumulators. Ribbe.

6981. Electric batteries. Entwiele. (Smith and another.)

7883. Electric railway, etc., systems. Devonshire. (Steinmetz and another.)

9530. Incandescent electric lamps. Devonshire (Wirt.)

9531. Dynamo-electric machines. Devonshire (Steinmetz)

10124. Distributing electric currents. Devonshire. (Steinmetz.)

10134. Collecting electricity from overhead conductors. Brewer.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5¾-6¼
Brush Company, Ordinary	3	1⅛-1⅜
—— Non. Cum., 6 per cent. Pref.	2	1¼-1½
—— 4½ per cent. Debenture Stock	100	112-115
Charing Cross and Strand	5	8½-8¾
Chelsea Electricity Company	5	7½-8
—— 4½ per cent. Debentures	100	114-116 xd
City of London, Ordinary	10	14½-15½
—— 6 per cent. Cumulative Pref.	10	16¾-17¼
—— 5 per cent. Debenture Stock	100	133-137 xd
City and South London Railway, Consolidated Ordinary	100	43-45
—— 4 per cent. Debenture Stock	100	135-137
—— 5 per cent. Pref. Shares	10	14¾-15¼
County of London and Brush Provincial Co., Ordinary	10	8½-9½
—— 6 per cent. Cum. Pref.	10	13¼-13¾
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
Edison and Swan United Ordinary	3	1½-2
—— 4½ per cent. Debentures	100	103-106 xd
Electric Construction, Limited	2	1¼-1½
—— 7 per cent. Cumulative Pref.	2	2½-3
Elmore's Copper Depositing	2	[illegible]
Elmore's Wire Company	2	[illegible]
W. T. Henley's Telegraph Works, Ordinary	10	17-18
—— 7 per cent. Preference	10	17-18
—— 4½ per cent. Debentures	100	109-114
House-to-House Company, Ordinary	5	4-4½
—— 7 per cent. Preference	5	8-8½
India Rubber and Gutta Percha Works	10	21-23
—— 4½ per cent. Debentures	109	105-108
Isle of Man Electric Trams, Ordinary	1	1¼-1¾
—— 6 per cent. Preference	1	1⅛-1½
Kensington and Knightsbridge Ordinary	5	9-9½
—— 6 per cent. Pref.	5	7½-8
Liverpool Electric Supply, Ordinary	5	8-8½
Liverpool Overhead Railway	10	14-14½
—— 5 per cent. Pref.	10	17½-17⅞
—— 4 per cent. Mortgage Debentures of £100	100	112½-114½ xd
London Electric Supply	5	1-1½
Metropolitan Electric Supply	10	13-14
—— 4½ per cent. First Mortgage Debenture Stock	100	119-121 xd
National Telephone, Ordinary	5	7⅜-7⅞
—— 6 per cent. Cum. First Pref.	10	17-19
—— 6 per cent. Cum. Second Pref.	10	16½-17½
—— 5 per cent. Non. Cum. Third Pref.	5	6¾-7
—— 3½ per cent. Deb. Stock	100	105-108 xd
Notting Hill Company	10	10-10½
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8¼-8¾
—— £4½ shares	4½	7¼-7¾
Oriental Telephone and Electric Company	1	¾-⅞
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	105-107
Southampton Electric Company	5	4¾-5¼
St. James's and Pall Mall, Ordinary	5	11¾-12¼
—— 7 per cent. Pref.	5	9½-10½
Telegraph Construction and Maintenance	12	38-41
—— 5 per cent. Bonds	100	102-105 xd
Waterloo and City Railway, Ordinary		8-8½ xd
Westminster Electric Supply, Ordinary	5	10¼-10¾
Yorkshire House-to-House	5	7½-8

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NOTES.

Obituary.—The death is announced at Bonn of Prof. Friedrich August Kekule, the chemist, at the age of 67.

Lord Kelvin.—The London *Gazette* contains the official announcement that the Queen has conferred the Knight Grand Cross of the Royal Victorian Order on Baron Kelvin.

Gas Tramcars.—They are going to try gas-motor tramcars at Blackpool, and the opening show took place last Saturday. As they have already an electric tramway there on the conduit system, it will be interesting to compare results.

Tramways Institute.—The annual dinner of the Tramways Institute of Great Britain and Ireland is to be held at the Holborn Restaurant on Friday, July 31. The Right Hon. C. T. Ritchie, President of the Board of Trade, is to be one of the guests.

Telephones in Spain.—The series of articles against the interurban telephones continues in *El Telegrafista Español.* The main trouble appears to be that the interurban telephones take away custom from the Government telegraphs, and hence profit from the State. The Spanish public, however, do not appear to be equally indignant with the companies for stretching their concessions when it results in a cheap and convenient service.

Lightning.—It is stated that during last week's storm an ash tree on the common at Elmham, in Norfolk, was struck by lightning and the trunk split right through the whole way down. The base of the tree was rotten and was set on fire. The "Reeve of the Common"—a mediæval kind of a name to linger in a Norfolk parish—had the tree cut down. A curious point is that the foliage of the tree is said to have appeared quite unhurt.

Thief Detecting.—They are up to date at the Roman Catholic church at Folkestone, and put electric alarm bells in connection with the alms-boxes. A gentleman named Charles Smith, who wished to take the distribution of the alms into his own hands, was promptly caught last week in this way, and the local Bench gave him two months'. The report adds that he wore a false beard, though how that should assist him in robbing alms-boxes does not appear.

German Electro-Chemical Society.—The annual meeting of the Deutsche Elektrochemische Gesellschaft took place at the end of last month at Stuttgart. Prince Hermann of Saxe-Weimar-Eisenach was at several of the sittings. About a hundred members of the society attended. Among subjects discussed were the Kellner process, electrolytic dissociation, measurements (including the measurement of very high resistances), and the Röntgen radiations.

Coast Telephones.—It is stated that the Government intend to at once push on the completion of the coast telephonic communication in the Bristol Channel, and engineers are now engaged in setting out the last route of wires from Ilfracombe to Lynton. The system has been found most useful, especially during heavy gales and notifying ships in distress, while the connected coastguard will have the whole of the look-out stations in the Bristol Channel under their command.

Tramways and Street Cleaning.—Mr. A. J. Reynolds, a New Englander who has emigrated to Canada, has invented an arrangement for street cleaning to be worked in connection with electric tramways. The idea is to sweep the streets cross-wise, leaving the sweepings on the tram tracks. Mr. Reynolds's sweeping car then comes along, picks them up with rotating brushes, boxes them, and carries them off. It is stated that the Montreal Street Railway Company intend to give the plan a trial.

Presentation.—Last Friday evening a very interesting meeting was held in Ediswan-buildings of the sales staff of the Edison and Swan Company, when Mr. C. M. Downie presented a handsome marble clock to Mr. A. H. Hunt, of the company, on the occasion of his marriage with Miss Agnes Chapman. Mr. Downie, in a short speech, complimented Mr. Hunt upon his past services, and expressed the hope that in his future matrimonial state he would be as successful as he had been in his business capacity.

Spain.—According to the *Revista Tecnológico-Industrial*, electric lighting is making steady progress in Spain. Among a list of new installations it may be noted that at Ecija, Cieza, and Carbellino, water powers are to be utilised. Eight other places are mentioned as having work either in progress or just completed, with a view to electric lighting. At Nájera, in Logroño, it is proposed to put down an electric tramway between the town and the railway station at Cenicero, as well as to light various villages on the route.

Electricity in the Nursery.—A note in *L'Elettricità* says that a Frenchman has discovered a new use for electricity, and has invented an arrangement by which the cries of a baby are received in a microphone placed in the cradle over the infant's head, and by some intermediate mechanism not described start the current in a circuit containing an electric bell. The mother or nurse can thus be summoned from any distance. Unless we are mistaken, our Milan contemporary described something of the same sort at much greater length nearly nine months ago.

Personal.—Mr. Vesey Brown, the electrical engineer for Sunderland, has decided to accept a similar appointment offered him by the Lincoln Corporation. At the last meeting of the Sunderland Corporation a motion increasing Mr. Brown's salary by £90 at once, and promising a further increase of £50 at the expiration of the year provided he would enter into a three years' engagement, was passed. Mr. Brown, however, has decided to go south. Though he will be required in Lincoln almost immediately, he will superintend the electrical extensions about to be carried out in Sunderland. Mr. Brown is a nephew of Lord Kelvin.

A Chicago Accident.—According to the *Western Electrician*, a couple of firemen, in endeavouring to extinguish some waste that had caught fire in the basement of the power-house of the Chicago City Railway Company, sustained severe shocks from current conveyed along the stream of water. They were rendered unconscious, but soon recovered. It will be remembered that some time ago a scheme was imputed to Mr. Edison by which the stream of water from a fire-engine was to be rendered additionally unpleasant to those it hit somehow in this way, but the public were never favoured with the details, the working out of which to an ordinary engineer would present some points of difficulty.

Telegraphs in Rhodesia.—Captain Roach, who is in command of the Salisbury-Tete section of the Trans-continental Telegraph Company's construction party, has been giving some particulars of his work to a Cape Town interviewer. His chief difficulties have been in the transport of materials, the tsetse fly prohibiting wagon transport beyond certain points. So everything has to go on the heads of Mashona and Zambesi "boys." Iron poles are used which, unless jointed, seem awkward things for native carriers in a rough country, and some of the country between Salisbury and Tete is very rough. However, they are better than wood, and prevent the necessity of coming to some sort of an arrangement with the wood-eating insects. Lastly, there was the country fever, which the construction party did not escape.

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Submarine Boat.—Mr. C. Seymour-Allen is reported to have designed an electrically-propelled submarine vessel, which has got as far as a 6ft. model exhibited in a swimming-bath. The new boat is called a submarine torpedo vessel and blockade runner, and the inventor says that it will be possible to remain under water, not for hours merely, but for weeks and months at a time. Compressed air is to be stored for breathing purposes, and "the motive power is electricity." This looks like accumulators. Storage batteries are very nice things, but everyone would not care to be shut up with one in an airtight boat under water for "weeks and months at a time." However, they do not consume air or vary in weight, which are great virtues in submarine work.

Telephones in Abyssinia.—A paragraph has been going the round of that portion of the Press that knew no better describing Abyssinia as having an amount of telephonic communication which might easily put some European and civilised countries to shame. The paragraph was absurd on the face of it to anyone who knew anything of Abyssinia and the state of things prevailing there. The report, however, was not absolutely baseless, for it appears that a Brussels electrician did receive an order for telephones for King Menelek's "palace," and actually went out to execute it. Probably the rest of the report arose from some slight confusion between what the enterprising Belgian actually had done and what he fully intended to do in the matter of educating the Abyssinian in the ways and wants of European civilisation.

Proving a Fracture.—Röntgen photographs have been accepted in an assize court as evidence in the matter of an actress's ankle, but now they have descended to the county court. At the Liverpool County Court on Monday a dock labourer sought to recover, under the Employers' Liability Act, £150 from Messrs. T. and J. Harrison, shipowners, for personal injuries. The liability was admitted, and the only question was the amount of compensation. The plaintiff was knocked down by a boom and his arm broken. In order to show the nature of the fracture, photographs of the injured arm, taken by Dr. Buchanan by means of the Röntgen rays, were produced. Counsel objected, but the judge admitted the photographs, their authenticity being proved in the usual manner. Possibly the jury might have preferred a gratuitous exhibition of the cryptoscope screen in a dark room; but they gave the plaintiff £60 damages.

Discharging Effect of Light.—Prof. Warburg, speaking at the Berlin Physical Society, maintained that the action of ultra-violet rays in facilitating sparking and the discharge of negatively electrified bodies consists in doing away with the retarding force which, according to Jaumann's researches, exists at each discharge. Gases, unlike metals whose conductivity is independent of strength of current, only become conductors when the current has reached a certain intensity; hence possibly during the retardation the gas is becoming a conductor, and if so, the action of light consists in the removal of some obstruction to the establishment of conduction. All of which, if it comes to anything at all, only means that if a system in stress is just about to break down, any vibration accelerates the catastrophe. But really very little is known about it. Nor is it any answer to the question why the effect is different on positive and negative charges, so far as ordinary ultra-violet light is concerned, while the Röntgen waves show no preference in the matter.

Royal Society.—At the Hôtel Metropole on Tuesday the Royal Society entertained at dinner the foreign delegates to the international conference convened for the purpose of forming a catalogue of scientific literature on principles which shall be universally accepted. The chair was taken by Sir Joseph Lister, P.R.S., and there were also present, among a large number of distinguished guests, the following whose names will be familiar to electrical readers: Sir F. Abel, Prof. Armstrong, Prof. Ayrton, Sir F. Bramwell, Sir W. H. Flower, Sir D. Galton, Dr. Gladstone, Sir John Gorst, Prof. Greenhill, Prof. J. V. Jones, Lord Kelvin, Prof. Liversidge, Mr. Lockyer, Mr. Preece, Lord Rayleigh, Prof. Roberts-Austen, Prof. Rücker, Sir Gabriel Stokes, Prof. Unwin, and Prof. Van't Hoff. Sir John Gorst represented the British Government, and the agents-general for most of the important colonies were there, while the presence of ambassadors and foreign ministers showed that foreign governments are in many cases less backward in recognising the claims of science than our own. There was a reception the day before at Burlington House; but one list of names at a time is enough for a note.

British Association Meeting.—During the meeting of the British Association in Liverpool, in September, a number of the owners of works of manufacturing and engineering interest will open their establishments for inspection. The half day excursions on Saturday, September 19, include: (1) River excursion with the Mersey Dock Board; (2) overhead electric railway; (3) Speke Hall, Hale Hall, etc.; (4) Thurstaston, Storeton Quarry—where the reptilian footprints are found, and the Leasowe submarine forest; (5) Bidston Observatory; (6) Chester and Hawarden; (7) dredging excursion with the Lancashire Sea Fisheries steamer. Whole-day excursions on Thursday, September 24: (1) Chester and Eaton Hall; (2) Rivington Waterworks, etc.; (3) Llandudno and Beaumaris by sea; (4) Manchester Ship Canal, etc.; (5) Prestatyn, Tremerchion Caves, and Corwen; (6) Northwich, Weaver Navigation, and Delamere Forest. At the end of the meeting there will be longer excursions, extending over several days, to the Vyrnwy waterworks in Wales, and to the English lakes; and a specially scientific excursion to the Isle of Man, for which a separate programme has been prepared, covering five days—Thursday to Monday inclusive.

South-West London Polytechnic.—In the course of the nine months since this institution has been opened, about 1,400 students have availed themselves of the educational advantages to be obtained within its walls. Up to the present time, with the exception of the art department, the work has been mainly in the evening; but at the suggestion of the principal, Mr. Herbert Tomlinson, F.R.S., and aided by a grant from the Technical Education Board of the London County Council, the governing body have wisely decided to throw open the workshops, laboratories, and classrooms to day students. The scheme of the day classes is to be that of the Finsbury Technical College, which has now stood successfully the test of years. There will be no overlapping between the work of the institute and the Central Technical College in Exhibition-road, inasmuch as one of the objects of the present scheme is to render the South-West Polytechnic a feeder to the Central Technical College. The institute is provided with two chemical laboratories, affording accommodation for about 60 students working at one time, two physical laboratories accommodating between 40 and 50 students at once, and two mechanical laboratories, as well as also workshops for various trades. The institute is lighted throughout by electricity, and the electric light and plant are available for experimental purposes.

Wind Power.—A paper which Mr. E. O. Baldwin, of Dixville, Quebec, read before the Netherlands Society for the Promotion of Industry at Haarlem is published in the *Canadian Engineer*, and deals with Mr. Baldwin's attempts

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to utilise the power of the wind for producing current. They are strong at windmills in Holland, where they use them for pumping purposes, but the difficulties in the way of getting a useful supply of current are much greater than when the only work required is to lift water a short distance and speed regulation is of no importance. Mr. Baldwin's regulating apparatus consists of an additional coil on the field magnets to act as a demagnetising coil, and an electromagnet which attracts a pivoted iron arm against the resistance of a spring and throws the demagnetising coil into the field circuit whenever the voltage rises above the desired point. There is a very rapid vibration of the arm, and Mr. Baldwin states that he can adjust the regulation so that lamps can be run directly off a dynamo belted to the windmill without any perceptible flickering. Normally, however, a storage battery is used. There is, however, with every deference to Mr. Baldwin, a much more important question to be solved than that of regulation—namely, what is to be done in a period of calm. Accumulators on a large scale are expensive, and the decline and fall of the wind-driven flour-mill is not a hopeful augury.

Sarajevo. — One result of the "occupying and administering" of the provinces of Bosnia and Herzegovina by the Austrians is that Sarajevo has been supplied with a system of electric lighting and tramways. The current for both of these is supplied from one generating station. The installation was done by Siemens and Halske, and a description of it given at the Vienna Electric Engineering Association by Mr. Ludwig Spängler has been reprinted in the *Zeitschrift für Elektrotechnik.* From this it appears that the lighting is on the three-wire continuous-current system at 110 volts. Accumulators are used in the distribution, so that a voltage of from 300 to 350 can be dealt with, and in this way it becomes possible to use "one and the same engine for both lighting and tramway work." There were originally three engines of from 150 h.p. to 190 h.p. each, but an additional one of 300 h.p. is to be provided with a view to extensions. Private lighting is provided for on a basis of 6,500 16-c.p. lamps, and there are 765 incandescent and 36 arc lamps for public lighting. The tramway is on the overhead system with return through the rails. For the passenger traffic there are five motorcars and eight trailers. An electric locomotive is provided for the goods service. The combination of lighting and tramway work enables a larger type of machine to be used than would otherwise be possible, only one of the engines being run in the daytime. It is claimed that considerable economy results, and Mr. Spängler thinks that such systems of combined lighting and tramway work have a great future before them in providing for the necessities of comparatively small towns, and therefore deserve particular attention. No figures or details of working are, however, available by which to judge the results attained.

Motorcarts.—There is to be a motorcart race from Paris to Marseilles and back on October 1 of the present year. The race has been arranged by the Automobile Club of France. The posts of honorary presidents of the committee of arrangement are filled by Messrs. Marcel Deprez and Georges Berger, that of president by Mr. Edmond Recope. Mr. Henri de la Valette acts as secretary. It is reported that the Lord Provost of Aberdeen has been trying a motorcart. It was an oil-motorcart, but it indicates that the authorities of that northern borough have reasonable ideas as to the propriety of enforcing an obsolescent statute. It is a pity that the same views do not prevail elsewhere. Meanwhile the legalisation Bill has got into the Standing Committee on Law, and last Friday Mr. Chaplin carried an amendment there fixing the maximum weight for motor-carriages at three tons unladen. A subsequent amendment provides that the weight of "water, fuel, or accumulators used for propelling the vehicle" is not to be included in this weight. That is good for electric motorcarts, and not bad for steam, but the steam-cart has got to make its exhaust invisible. So far as the roads are concerned, it would have been almost as well to have left the maximum weight at four tons "all on," and would save disputes. Lastly, Mr. Griffith Boscawen moved a new clause providing that Sub-section 4 of Section 28 of the Highways and Locomotives Amendment Act, 1878, might be from time to time varied by the Local Government Board. The sub-section specifies a particular pattern of driving wheel to be used on locomotives on roads, and this pattern had been found to be most injurious to many roads. The clause was added to the Bill, and it was ordered to be reported with amendments to the House. The Britannia Motor Carriage was shown privately at the Imperial Institute on Wednesday.

Closed-Conduit Tramways.—The New York *Electrical Engineer*, in the course of an article on the Johnson-Lundell system tramway, which has been running in West Thirty-fourth-street, New York, for about four months, gives some details as to the amount of leakage from the contact points which may be worth notice. After a description of the circuits and electromagnets used to make those contact-pieces under the car "alive" the article proceeds: "When no car is running, and consequently no contact points are alive, there is absolutely no leakage possible on the system in any kind of weather, owing to the high insulation of the main conductor and switch magnets. There is also no leakage in dry weather when the cars are running. It is readily seen that when any leakage does occur it can only be at the point directly under a car where the contacts are alive. During a rain storm, or immediately after, the leakage from a positive contact point is about a quarter ampere, and from the whole contact bar about one ampere. The greatest leakage appears to be due to snow and slush during the winter, but no accurate data could be secured owing to the difficulty of taking readings while the car was running on a crowded street. On the day after a heavy snowstorm when the track rails and contact points were entirely submerged in water and snow, the leakage from the positive contact bar appeared to be only from three to five amperes." It should be stated that the voltage is 500. It may also be added that each car carries a storage battery consisting of 200 cells of small capacity, divided into halves and placed under both ends of the car beneath the floor. This battery is used on starting the car only, except when it may be called into use by some emergency. Its function is to start the switch magnets, making the contact points "alive" when the car is standing still and the switch magnets are all open.

Industrial Chemistry.—The fifteenth annual meeting of the Society of Chemical Industry was opened on Wednesday at Carpenters' Hall, London-wall. The society's medal "for conspicuous services rendered to chemistry by research, discovery, invention, or improvement in processes, irrespective of membership," was awarded to Mr. John Glover, the inventor of the Glover tower. Mr. T. Tyrer delivered the presidential address, and in the course of it remarked, in comparing English with Continental work, that the conclusion he had arrived at was that the real cause of the progress and prosperity of German chemical industries was to be found in the superior qualifications of the directing minds there. Again, the Austrian Government did all it could to promote industry, and

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especially chemical industry, whereas in England, where the Government could readily obtain and spend £18,000,000 on armaments, £4,000 only went to the endowment of research. With the resources of this wealthy country, and the public spirit of its citizens, we ought to remain very little longer in the present state of obvious backwardness. Our elementary training was defective, but we looked forward to the time when the State and public bodies should here, as in Germany, foster our industries by a sound system of education—even in economics for the leaders of the workmen. It would undoubtedly be very nice if Mr. Glover's suggestion could be carried out. Unfortunately, there are so many people that carefully abstain from understanding an argument if they are afraid that it leads to conclusions that are distasteful to them. Try, for instance, to demonstrate to a trades union leader that, as a rule, strikes do not pay, or to a manufacturing member of Parliament that there are other things to be considered besides so organising industry as to do things 1 per cent. cheaper than the foreign competitor. As a matter of fact, there is nothing more disappointing to believers in progress than the way in which the reasoned conclusions of political economy have been thrown aside by leaders of all parties of late years. In the evening many of the members of the society were entertained by the Lord Mayor and Lady Mayoress at a reception at the Mansion House, where they met the president of the Royal Society (Sir Joseph Lister) and the members of the International Conference on the Classification of Scientific Literature. Among those present were Mr. Norman Lockyer, Prof. Jebb, M.P., Prof. Michael Foster, Prof. Roberts-Austen, Dr. and Mrs. L. Mond, Mr. and Mrs. A. Siemens, Prof. C. Lapworth, Prof. A. W. Rücker, Prof. A. B. W. Kennedy, and Mr. W. Huggins.

Arc in a Magnetic Field.—Mr. J. B. Hall has described in the *Canadian Engineer* some experiments he made on the effect of running an arc in a magnetic field. An "anchor-ring" core electromagnet with a gap in it appears to have been used, the carbons being arranged in the air-gap parallel to the direction of the lines of force and in the centre of the field. The current passed first through the magnetising coil and then to the arc. Cored carbons were used, and, from the diagram given in our contemporary, the arc was a horizontal one: "The first test was the starting of the arc uninfluenced by magnetism. It burned quietly, with the carbon anode assuming the usual crater-like form. The distance between electrodes being about $\frac{5}{16}$in., the heated currents of air caused it to move from side to side. The current was 9·5 amperes and 51 volts. Then the arc was started influenced by the field, having a strength of 250 C.G.S. lines, the carbons being so placed that the axis of the arc was parallel to the lines of force. It was very noisy, and the arc spread to the outer edge of the anode (leaving the inner core untouched), in the form of an inverted cone, numerous points of light brighter than the rest of the arc being seen, while the flame rotated in the direction of the flow of current in the coil. The carbon was consumed very slowly in proportion to what was burned in the uninfluenced arc, and the apparent temperature of the arc seemed one-half of the uninfluenced arc. The resistance in the gap between the electrodes decreased so that the current passing was 11·2 amperes and 47 volts. (The primary voltage was 110 volts, current from an incandescent circuit being used, with stationary water resistance interposed to reduce the voltage.) The arc at the cathode narrowed down to a very fine point, never wavering, and remaining in the same place. The field was increased to 500 C.G.S. lines and the effects were only augmented, the rotation being more rapid, the noise louder, and the resistance decreased until 14 amperes at 42 volts were passing. The field was then increased to 1,000 C.G.S. lines and the noise became a roar, the arc curled out and around the anode's outer edge, yet maintaining a point at the cathode; the current became 20 amperes at 34·5 volts; its rotation was no longer visible, and the points of light dispersed over the edge of the anode, multiplied until it bore a resemblance to 'stipple' work." Subsequently, the positive carbon was placed crosswise to the field, and consequently at right angles to the negative carbon, when it is stated that, with a field of 1,000 C.G.S. lines, "the arc started around the anode until it reached the other side farther away from the cathode," and the current fluctuated rapidly. No measurements beyond those embodied in the extract quoted are given, nor is the direction of the winding stated, but further experiments are promised.

Brooklyn Tramways.—It is well known that the working of the Brooklyn tramways has been made use of by the enemies of electric traction for the purpose of discrediting that system. It is therefore well to know the cause of the numerous accidents there. The New York *Electrical Engineer*, which is in a position to know all about it, says, "The city of Brooklyn has had, perhaps, more fatalities than any city where the trolley system has been introduced, but most, if not all, of these accidents have been due to the carelessness of individuals or the running of cars at too high a speed." In certain parts of Brooklyn, where lines from numerous directions converge to several centres, and where traffic is extremely congested during certain hours, both pedestrians and motormen can only avoid accidents by the use of extreme caution. A recent accident, however, cannot be referred to this cause, as it was occasioned by the running away of a car backwards on a down grade. "From every account which has been published," says our contemporary, "it seems apparent that the motorman was far less to blame than the conductor and the equipment of the car, for which the company is responsible. In the first place, the car was crowded far beyond the limit of safety, and it certainly comes very close to criminal negligence to permit 133 passengers to ride on a car that was built to carry 50 people. When a car is overcrowded in this way it almost always happens that most of the crowd is concentrated near the rear of the car. This takes the weight off the front wheels, so that even if they are stopped by the brake it has but a small effect on stopping the car if the grade is considerable. The use of heavy cars of extra length, which are run at the rate of 15 miles an hour or more at some points of the road, is entirely incompatible with the use of hand-brakes of any description, and they are particularly inadequate in the case where heavy grades are to be encountered. Apparently the company realised this fact, as it had adopted the primitive method of stationing two men at the dangerous grade armed with planks to throw under the wheels of runaway cars. What is really needed in this case is a power brake. As a matter of fact, the brakes on trolley cars in general have never kept pace with the requirements of the latter. While the weight and speed of trolley cars are greatly in excess of that of any horse-car, the same brakes are frequently used indifferently on both cars, the extra power necessary for the trolley car being supplied by the motorman. On a road where heavy grades occur, emergency brakes of some kind are almost indispensable, and emergency brakes should be applied to the car in such a way that both they and the ordinary hand-brakes co-operate independently. This precaution is required in case of the disablement of either one, as was the case in the

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accident above alluded to." In general there is plenty of space in American streets, but the distances are great, and consequently a high speed is sure to be the rule. Moreover, there is room to get out of the way. Where, however, this does not happen to be the case, it would have been well from every point of view to adopt a slower and more European way of working the traffic. It is right to go ahead whenever possible, but it must not result in running violently backwards.

Temperature and Insulation.—Mr. C. E. Skinner's investigations of the effect of temperature on insulating materials, and especially such as are used in the construction of dynamo and motor armatures, have been summarised in a communication to the American Institution of Electrical Engineers. The results have been mentioned before, but not the apparatus used. A series of tests were undertaken to determine the effect of temperature on the insulation resistance and breaking-down E.M.F. of various insulating materials and also of completed apparatus, and a large number of insulating materials, including paper, cloth, etc., both in the treated and untreated forms, were tested. For testing materials the apparatus finally adopted consisted of two similar plates, between which the insulating material is placed when tested. These plates are 10in. in diameter, and are carefully surfaced. Each part is made of two separate pieces of cast iron, fastened together, and wound with a coil of asbestos-covered wire. The heating of the apparatus is effected by sending an alternating current through the two coils in series, and results from the eddy-current and hysteresis loss in the iron, as well as from the copper loss in the coil. The rate of heating can be controlled easily by means of a suitable rheostat in circuit with the coils, the mass of iron in the heater being sufficient to prevent sudden changes of temperature from outside causes. The insulation resistance of the samples was measured in all cases by means of a high-resistance voltmeter on a 500-volt circuit, all wires of the heating circuit being disconnected when the insulation measurements were made. A curve was obtained from tests on a piece of untreated paper. The minimum resistance was reached at slightly below 100deg. C. From this point the resistance rises rapidly until it reaches a point too high to be measured with the apparatus used. The absolute value of the insulation resistance of any material of this class depends on the amount of moisture in the material at the start, the rate of heating, and the chance for the escape of moisture during the test. The absolute value of the insulation resistance of treated material depends largely on the drying of the material before treatment. Samples of cloth which were treated with linseed oil after being thoroughly dried and then the oil baked on do not at any time show a very low insulation resistance, even at a temperature of 150deg. C. No relation could be found between the breaking-down E.M.F. and the insulation resistance, for though a low insulation resistance usually meant a low breaking-down test, a low breaking-down test did not necessarily mean a low insulation resistance. Mr. Skinner's conclusions are that (*a*) the insulation resistance of all ordinary fibrous insulating materials, such as paper, cloth, etc., decreases upon being heated up, and then increases again when the moisture is expelled; (*b*) continued heating of 31 hours at 120deg. C. does not lower the insulation resistance of paper; (*c*) the insulation resistance of completed apparatus shows the same characteristics as the insulation resistance of materials taken separately; (*d*) a low insulation resistance is not necessarily an indication of poor insulation, but probably an indication of the condition of the apparatus in regard to moisture; (*e*) a high E.M.F. should not be applied to apparatus when the insulation resistance is low; (*f*) material which is badly deteriorated mechanically by heat may still have a high insulation resistance, but very poor insulating qualities.

Rontgen Radiations.—The annual meeting of the Victoria Institute was interesting as being the occasion of the expression by Sir Gabriel Stokes and Lord Kelvin of their views on the theory of the Röntgen radiations. Sir Gabriel Stokes dealt with the subject in his presidential address. He had never himself made experiments with the Röntgen rays; but he had followed closely what others had done, so that he could not but think that he had a tolerably good idea of the nature of these rays, and had arrived at the conclusion that they were, like ordinary light, due to transverse vibrations, but of excessively high frequency. As was indicated in these columns in the early days of the discovery, there seems no other explanation possible, since it was clear that if longitudinal vibrations were transmissible in air, they must be constantly produced, and it would not be possible to keep a sensitised plate in an ordinary cardboard box. It is therefore satisfactory to know from a mathematician of Sir G. Stokes's eminence that there are no insuperable theoretical difficulties in the way of its acceptance. Lord Kelvin, who moved the vote of thanks for the address, said Sir G. Stokes had gone into a very full and most interesting and important statement regarding one of the greatest discoveries of this century, but all that he had touched upon was full of contentious matter. The scientific world had been gravely agitated upon this subject since the beginning of January, and almost every sentence uttered by Sir G. Stokes was strongly in opposition to a great deal that had been published by many exceedingly able men, both mathematicians and experimenters. Personally he had listened with the greatest possible satisfaction and comfort to the declarations of Sir G. Stokes. When he heard Sir George declare for transverse vibrations, and the strong reasons put forward for that conclusion, he felt himself very strongly fortified in accepting it. They must not, however, forget that what had been put before them had not been absolutely demonstrated. Whilst Sir George Stokes had tantalised their minds very much by leaving them open to the possibility of some other explanation, he had certainly left them with the impression that it was exceedingly probable that the Röntgen rays consisted of transverse vibrations, but a hundredfold more frequent in a second of time than the transverse vibrations of ordinary visible light, so that if there were about seven hundred million million vibrations per second in green light there must be seven hundred hundred, or seventy thousand, million million vibrations of the Röntgen rays per second. Mathematicians and experimenters who knew the properties of light felt very much astonished to think that exceedingly sharp impact of the electrified particles proceeding from the cathode and striking against a target should produce vibrations of hundred times greater frequency than the luminiferous vibrations of all the qualities of light previously known. They must all feel that the curtain had been drawn from before their eyes, and that they had been allowed to look into some of the mysteries of Nature. If Lord Kelvin says so, no doubt it is as he says. But it is not very clear why anyone should be astonished at the possibility of an atom or a molecule producing vibrations which are not large compared with its own size, and that is really all that is required. As to the "luminiferous medium," it properties are simply whatever happens to be wanted to explain the phenomena, and therefore it may be conceived capable of transmitting "waves" of any minuteness.

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THE 1896 MEETING OF THE VERBAND DEUTSCHER ELEKTROTECHNIKER IN BERLIN.

(BY OUR SPECIAL CORRESPONDENT.)

(Continued from page 37.)

The arrangements for Friday, the 19th of June, were all of the sight-seeing order. The quantity and quality of the sights depended only on the appetite of the individual. Thus the programme commenced at 9 a.m. with a visit to the electrical laboratories of the "Reichsanstalt"; from there the members proceeded at will to either or all of the following: the old and new works of the Allgemeine Elektricitäts-Gesellschaft; the works of Mix and Genest, the noted telephone manufacturers; and the Mauerstrasse station of the Berlin electricity works. After this heavy fare came a visit to the Berlin Exhibition, which was terminated at 7 p.m. by a gathering in the adjoining show, called "Kairo," where the usual Earl's Court performances were to be seen. I commenced well, but must admit that the fare was too abundant and that I did not conform to the full programme.

The electrical and physical laboratories of the Reichsanstalt, which are under the able superintendence of Prof. F. Kohlrausch, are situated at Charlottenburg. The history of the institution is somewhat as follows. In the early days of electric lighting work, Dr. Werner Siemens recognised the need of having an authority on electric standards for technical purposes which should be above suspicion. He rightly considered that such an authority would tend to uniform standards of current, voltage, and resistance being worked so throughout the empire, and that tests carried out by such an authority would settle at once any quantitative technical matter in dispute. He therefore gave the large site and a good proportion of the cost of erecting and equipping the laboratories we visited, on the understanding that the Government would support the institution and vest it with Imperial authority. The institute is therefore used largely for research work, and also for testing and calibrating commercial meters, etc. It is not endowed for educational purposes, although a number of young men do attend to assist the various professors in their work. The nearest approach to a similar institution in England is the small laboratory established at the Board of Trade office, Whitehall, by Major Cardew. This latter place, although not equipped for extended research work, is in my opinion quite as useful to the practical man for all purposes of reference.

We were shown round the laboratories of the Reichsanstalt by Prof. Feussnee and Dr. Lindek, who most carefully explained the various instruments in the different departments. I was impressed by the care shown over details. Thus the standard resistance coils for use on the potentiometer methods, to which Dr. Lindek has devoted so much attention, are immersed in oil baths. The oil in each vessel is churned by small screw propellers driven by means of fine catgut from a small motor. Thus a perfect circulation of oil is obtained and the cooling of the coil, if a moderate current is passing, is accelerated, so that the temperature of the oil gives practically that of the conductor immersed in it. The small accumulators used to give high voltages for calibrating voltmeters, etc., were beautifully arranged on hanging shelves. These shelves consisted of a tall vertical rectangle of strip iron with a series of horizontal braces across it. These formed the shelves on which the cells were supported. The usual insulation devices were provided by paraffined wood laid on insulators. The whole rectangular section thus built up hung on rollers at the top. Each rectangular section had 20 shelves, and each shelf was equipped with 25 small accumulators in series. This gives about 50 volts per shelf, so that the voltage when all are in series is about 1,000 volts. Ten of these sections are now provided, but they are not yet completely equipped with cells. The whole of the ten sections are enclosed in a glazed partition with folding doors. Thus, when any cell needs attention, its section can be pulled out, as it runs on the rollers mentioned above.

The meter-testing department was very well provided with meters of practically every type on the market. The arrangements for supplying current to them from either direct or alternating current dynamos, or from accumulators, were well and conveniently designed.

I heard a few facts about the bearing of this institution in the matter of electric railways which seemed of interest. It is the old story, "One touch of nature makes the whole world kin." An electric railway was projected which was to run through the Thiergarten and pass through Charlottenburg, not far from the Reichsanstalt. The heavy rails required for the traffic were laid, and a large amount of capital thus laid out. Then it was thought by the professors at the institute that their original researches in magnetism would be upset if such a line was worked electrically. Hence a series of objections to electric traction such as are kept in stock by the municipal authorities at Berlin (see the *Bier Zeitung*) were placed before the Government. As the institution is under Imperial control and influence it naturally gained the day, and electric traction on the lines in question was put back some years. The curious coincidence is that the firm of Siemens and Halske held the contracts or were working the scheme, and hence the Reichsanstalt was practically turning on its founder. The question as to whether such delicate magnetic observations are of supreme importance to the general profession is a moot point, but it is certainly my opinion that the general public would wish both the experiments and the experimenters to be subservient to the public convenience. In other words, the man who undertakes experiments which necessitate the retardation of the progress in his district becomes a public nuisance.

Leaving the laboratory, the bulk of the members of the Verband proceeded to the works of the Allgemeine Elektricitäts-Gesellschaft, which I hope to describe in my next article.

Interview with Mr. F. Ross, of Vienna, on a New Development in Accumulator Traction.

I found that Mr. Ross had taken an active interest in a system of accumulator traction now being used at Hanover and Dresden. This system is one which should commend itself to the English public, as with it the advantages of accumulator traction in the crowded parts of a town are available without undue increase in the running expenses. The system as explained by Mr. Ross is briefly as follows: The suburban portions of the lines are equipped with the ordinary overhead system, and each car is supplied with a set of accumulators. These are charged *in situ* when the car is running on the trolley wire. In the crowded or narrow streets, or in such places where the municipal consent to the erection of overhead wires cannot be obtained, the accumulators can supply the necessary current. In a town the proportion of the line which cannot be worked on the trolley system is usually not large, and hence the capacity and weight of the accumulator can be kept down much below that required for the complete accumulator traction system.

Mr. Ross informed me that in September last some half-dozen of these cars were started at Hanover, and the results obtained with them were so favourable that 40 more were ordered in November. A regular service is now maintained, some 35 cars being in use at one time. The engineer-in-charge at Hanover claims most advantageous results, even over the old costs, when the trolley system only was used. The expenditure in coal was less than before, due, as Mr. Ross explains, to the increased regularity of the supply from the power station. Thus, when the cars are on the suburban parts of the lines which are connected by the trolley wire to the supply station, the accumulators are working in parallel with the motors. In starting, the excess current required will be supplied to the motor by the accumulators. The charging current also will vary with the load on the motor, the general tendency of the variation being towards a constant current being taken from the line. The sharply-peaked curves now invariably found for the current output from traction stations will thus give way to curves having more gradual changes of smaller amounts. For a station supplying a few cars this change in the form of the curve is most marked, and will result in a comparatively large coal economy. For large stations, on

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the other hand, Mr. Ross does not think the saving in coal will be very much. It seems that the lines at Hanover are very favourable to tramcar work, as the grades are nowhere excessive. Mr. Ross has been retained to report on the financial results of this undertaking for the Vienna authorities. As the figures he had by him were not complete, and at the same time were privileged, he was unable to furnish me at the time with exact details. The working expenses up to now have been favourable, but he considered that more lengthy experience was required before the true cost could be obtained. The accumulators certainly are treated in the best way possible to ensure a long life, as there is no great interval between the charge and discharge period. The great advantage which this system gives is well instanced by the facts which led to its adoption at Dresden. Mr. Ross told me that at this latter city the traction company was compelled by the municipal authorities not to use the trolley system in certain streets. Not content with this restriction, the authorities went so far as to specify whose conduit system was to be used. After looking into the cost of the conduit system to which they were to be bound, etc., the company decided to adopt the accumulator system as above. In this way no alteration was required to the track.

The terms under which the Dresden companies were licensed by the municipality are as follows: The central station, the feeders, and return cables, the trolley and conduit systems, were to be erected by the municipality, which furnishes all the current to the companies under the following method of charges: to the actual working expenses are to be further added 5 per cent. interest, 2 per cent. depreciation on the cost of the buildings, 7 per cent. on that of the engines and dynamos, 10 per cent. on the cost of the boilers. The amount so obtained is further increased by 20 per cent. to give the actual sum to be paid. Over and above this the companies have to pay 10 per cent. per annum on the cost of the overhead lines, etc., and 15 per cent. per annum on underground feeders and conduits. I need hardly say that these terms are exceedingly favourable to the municipality. The minimum price paid up to the end of 1895 has been 1·62d. per kilowatt-hour delivered from the central station.

Mr. Ross kindly gave me an introduction to Prof. Ullbricht, of Dresden, so that I was able to view the cars while at work. Another interesting advantage I found was that where two rival electric lines coincide for a few hundred yards, as they do at one place in Dresden, the car with accumulators can there be run over that section without taking current from the trolley wire of its rival. With the improvements now effected in accumulators, and their lowered cost, this system seems a practical method of dealing with a necessity in towns where the trolley is forbidden in certain streets. Mr. Ross assured me that electric traction was making great strides in Germany, and that the rapid transit resulting from its use gained great favour with the people. The appreciation of the advantages derived from it in Leipzig was so great that the authorities had insisted on having two tracks in all the principal streets. Thus in some narrow streets electric traction seriously interfered with the ordinary vehicular traffic (two tracks were put in a street under eight yards wide). It was considered that the public gained more by the increased facilities of the electric cars than was lost by private inconvenience.

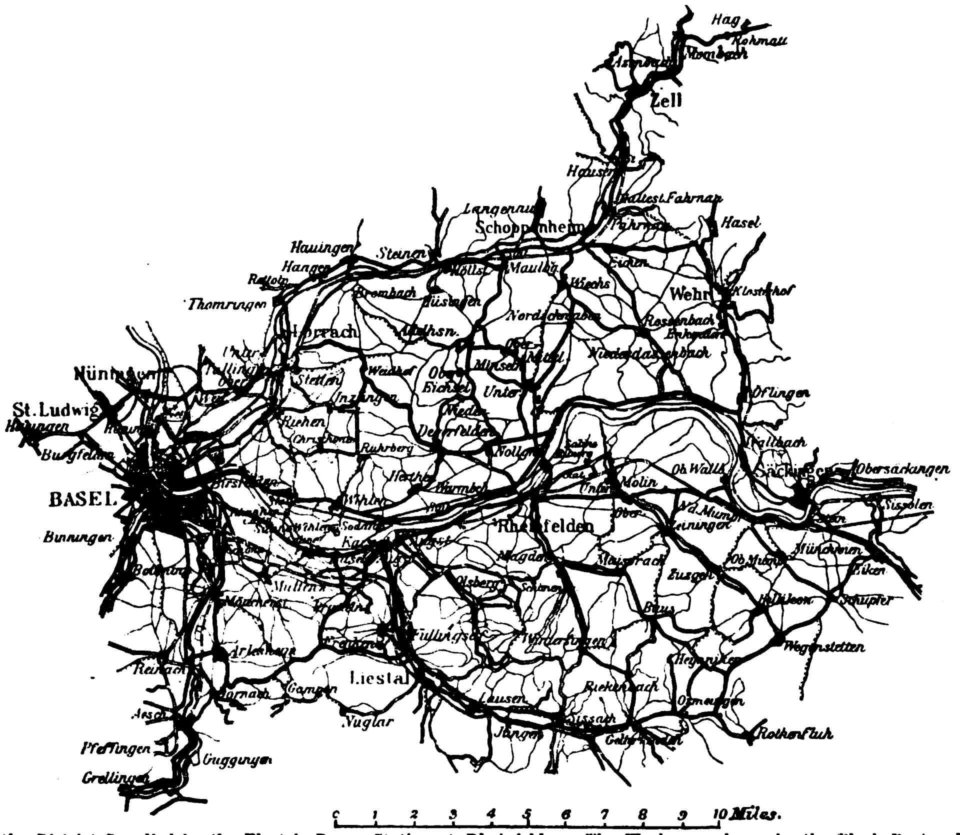

FIG. 1.—Map of the District Supplied by the Electric Power Station at Rheinfelden. The Works are shown by the Black Rectangles, and the Heavy Black Lines denote the Electric Mains

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Works for Transmission of Power at Rheinfelden.

The following is a brief *résumé* of the interesting paper read by Director Rathenau on the above subject:

The works (Fig. 1) are situated on the Rhine near Bale, and were erected for the purpose of utilising the water power there available. There are three rapids at this spot, between the Lake of Beugg and the Rhine bridge, having a total fall of from 21ft. to 24ft. 6in. This fall, however, varies very considerably with the quantity of water coming down the river. The available head at the turbine is that of the upper rapids only from 8ft. to 16ft. A canal, 165ft. wide at bottom, leads to the power-house containing 20 turbine-chambers. There are 20 turbines, each of 840 b.h.p. The present minimum water power is equivalent to 13,800 i.h.p., while the maximum is more than 15,000 i.h.p. The works have the option of further power to the extent of some 7,000 h.p. In this case they would utilse the fall between the present station and the bridge over the Rhine.

The quantity of water which can be taken through the works amount to some 12,400 cubic feet per second. The turbines are of Francis's reaction type, with two sets of driving vanes and guides. Their speed is 55 revolutions per minute, and they are coupled direct to the electric

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generators. The lubrication of the turbines is effected under pressure. When working at normal load they have a commercial efficiency of 75 per cent. As the head of water varies so much, the turbines have been designed to accommodate a varying quantity of water, so as to give constant power. The water passed by each turbine thus varies from 600 to 870 cubic feet per second. The type of electric generator used can be seen from the dimensioned sketches (Figs. 2 and 3). The dimensions are given in millimetres. These machines give three-phase current to the network. The design is so arranged that neither of the copper circuits revolves. The armature coils are wound on a laminated iron core, which in turn is fixed to a cast-iron base. As will be seen from the illustration, the magnetising coil for exciting the field is also fixed to a recess in this cast-iron base, so that no collecting rings are required. The revolving part consists merely of laminated blocks of iron inserted in a carrier of the same metal. The apparent output of each phase is 63 amperes at 3,800 volts, or 720 kilowatts in all. Owing to an 80 per cent. power factor, the author states that the true output is 580 kilowatts. The excitation is provided by three rotary transformers each of 150 h.p., which transform the three-phase alternating currents into continuous current for use in the field coils.

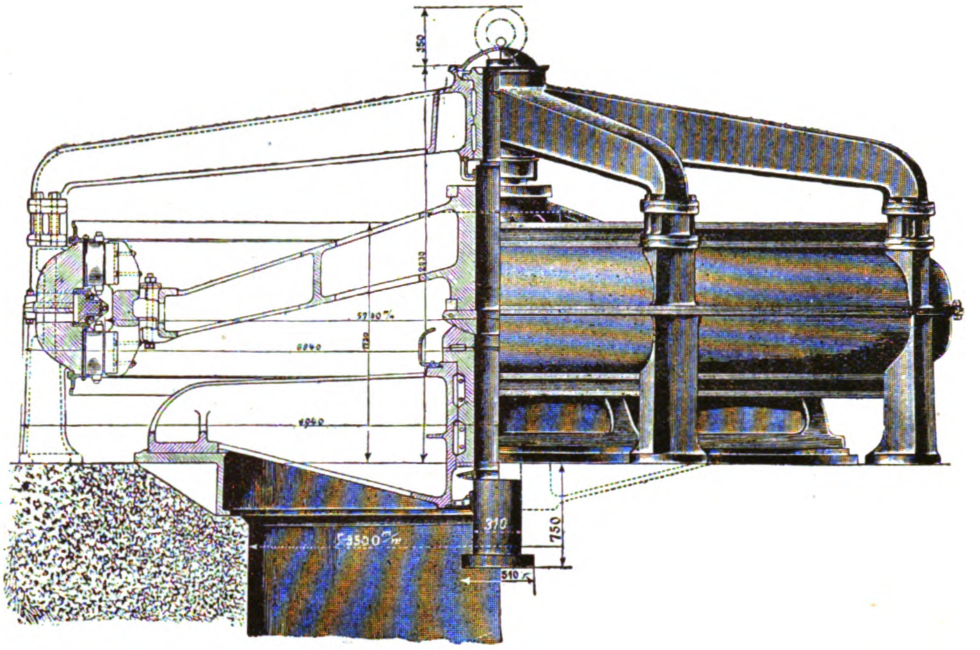

FIG. 2.—Sectional Elevation of the Three-Phase Generator at Rheinfelden.

The works are intended to supply energy anywhere within a radius of 12½ miles from Rheinfelden for industrial and lighting purposes. The area now being provided with mains is shown in Fig. 1. The pressure on the mains will be at first 6,800 volts, and will be supplied directly from the generators. As the demand increases the voltage will be raised to 16,500 volts to give economy in working, and the construction of the mains is such as to withstand this latter pressure. The increase from 8,500 to 16,500 volts will be obtained by transformers. The distribution will be carried out by two distinct systems of mains. One network will thus be used for power only and one only for lighting purposes. In this way the switching on or off of the motors will not affect the lamps, and a larger drop of pressure can also be allowed in the motors' network. The load for supplying the lights will be taken by four of the generators, while 14 will be required to supply the power network. It is estimated that at least half of the power thus delivered will be used for chemical processes.

The total area of distribution is sub-divided into a number of smaller areas, each with two independent distribution networks—*i.e.*, one for light and one for power. The pressure on these is respectively 120 volts for the light-distributing network, and 500 volts for power distribution. The four generators for light can simultaneously feed 35,000 16-c.p. lamps.

The mains used are of bare copper, supported on insulators on poles. The poles keep the wires some 36ft. above the ground at the point of support, and are spaced about 44 yards apart. The same poles carry also the pilot wires and the telephone service. Every 550 yards a lightning arrester is fixed. The current density on which the primary network is calculated is that of 580 amperes per square inch section. The total losses in the lighting circuit are then found to be such that 72 per cent. of the power on the turbine shaft is delivered to the lamps. On the motor circuits a larger loss is allowed, and the total efficiency of distribution falls to 68 per cent. The charges for energy supplied will be low—viz., maximum for light 4·8d. per kilowatt-hour. A sliding scale of discounts wil be allowed, which will reduce the price to regular consumers, the maximum discount being 80 per cent.

The price per kilowatt-hour for industrial purposes will be only 1·9d., but the first cost for installing will be charged, which will vary from £2. 10s. to £8, according to the size of the installation.

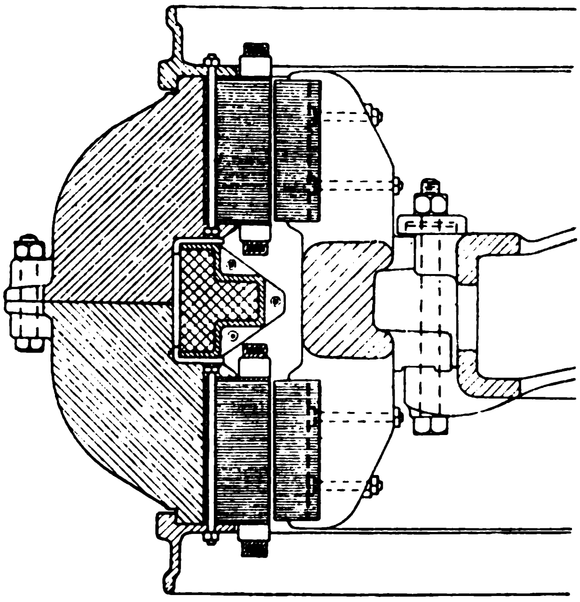

FIG. 3.—Large Scale Section of the Armature Field Magnet.

The rates for motive power will thus compete most successfully with the supply by small steam plants or even with large power. Mr. Rathenau gives the following comparisons for motors working 3,000 hours per year:

Power of motor. Horse-power.	Annual cost by— Steam-engines in the district.	Electricity at above rates.
5	£150	£40
100	1,300	855
1,000	7,875	5,500

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It is anticipated that these works will be of great benefit to the district by assisting the industries already established, by encouraging the starting of new factories, etc. The work is being carried out under the able supervision of Prof. K. Zschokke, the consulting enginer being Prof. Intze. The latter gentleman estimates that the first cost will be about £15 for every brake horse-power on the shafts of the turbine. The electric contracts are being carried out by the Allgemeine Elektricitäts-Gesellschafts.

(To be continued.)

THE PRINCIPLES OF ALTERNATE-CURRENT WORKING.*

BY ALFRED HAY, B.Sc.(EDIN.), A.I.E.E.

(Continued from page 18.)

23. After the brief exposition given above of the mathematical principles which we shall have to make use of, we may proceed to consider the fundamental physical facts on which the theory of alternating currents is based.

If the number of magnetic lines passing through any circuit is varied, an E.M.F. is induced in that circuit, which is measured, at any instant, by the rate of change in the number of lines at that instant. This is the principle underlying the construction of all kinds of dynamo-electric machines, and was discovered by Faraday as far back as 1831. The student is supposed to be already familiar with this principle, but it may not be out of place to direct his attention to some special points which will prove useful later on.

Lines of magnetic induction may be made to pass through a circuit either by placing it in a suitable position in the neighbourhood of a magnetised body (or conductor conveying a current) or by passing a current through the circuit. Changes in the number of lines which thread themselves through the circuit may be produced by (*a*) moving the circuit in the field in which it is placed; (*b*) moving the body producing the field; (*c*) altering the current which flows round the circuit; (*d*) distorting the shape of the circuit. The first two methods are made use of in the construction of dynamos and alternators, the third in the construction of transformers and various types of alternate-current motors.

The E.M.F. induced in the circuit lasts only so long as the number of magnetic lines passing through it is varying, and ceases as soon as that number becomes constant (when the rate of change, which determines the E.M.F., is zero).

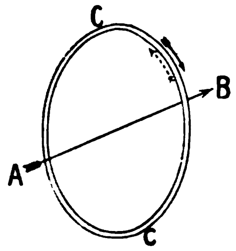

FIG. 14.

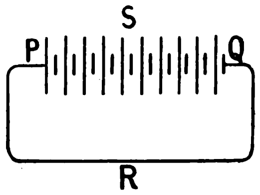

FIG. 15.

24. The *direction* of the induced E.M.F. is such that it always *opposes* the changes producing it. This principle is known as *Lenz's law.* Thus, let the vector A B in Fig. 14 indicate the magnetic field, and let C C_1 represent the circuit. If the length of A B is *diminished* the induced E.M.F. will have the direction indicated by the full-line arrow, and the current due to this E.M.F. would tend to *increase* the length of A B. On the other hand, if we suppose that A B is *lengthened*, the E.M.F. will have the direction shown by the dotted arrow, and the corresponding current would tend to *shorten* A B.

Let us next suppose that the line A B gives the direction of the field due to a current flowing in C C_1. The direction of this current will be that of the full-line arrow. If the current is diminished, the E.M.F. induced during the time that the current is diminishing will have the direction shown by the full-line arrow—*i.e.*, the induced E.M.F. will tend to increase the current; if, on the other hand, the current be made to increase, the induced E.M.F. (dotted arrow) will tend to reduce the current. In either case, therefore, *the induced E.M.F. tends to oppose the changes which give rise to it.*

25. The ratio of the E.M.F. to the current in a given circuit maintained at a constant temperature is defined as the resistance of that circuit. Ohm's law asserts that this ratio is a *constant quantity which is independent of the current.* Hence, Ohm's law may be written in the form

$$i = \frac{E}{r} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (17)$$

where i stands for the current, E for the E.M.F., and r for a certain *constant* which we agree to call the resistance of the circuit.

In applying Ohm's law to any circuit it must be remembered that E in the above equation denotes the total resultant E.M.F. in the circuit; or, if we are dealing with a portion of the circuit merely, E stands for the difference of potential across that portion, plus any E.M.F.'s which may be included in that portion. In many cases there may be more than one E.M.F. in a circuit, and in all such cases it is the *algebraical sum* of the various E.M.F.'s which must be used when applying equation (17). In order to impress this fact on the student's mind, we shall consider a few simple examples.

Let a battery of E.M.F. E, and resistance b, be connected up in simple circuit (Fig. 15) with an external resistance r. Since the E.M.F. of the battery is the only E.M.F. in the circuit, we at once obtain the current i from the formula $i = \frac{E}{b+r}$. Again, P and Q being the positive and negative terminals of the battery, since P is at a higher potential than Q, a current will tend to flow from P to Q. In the branch P R Q we have no E.M.F., so that if V denote the potential difference between P and Q, the current flowing from P to Q along P R Q is equal to $\frac{V}{r}$. In the branch P S Q, however, we have the opposing E.M.F. of the battery, so that the current which passes from P to Q along P S Q is $\frac{V-E}{b}$. Now, since E>V, it follows that V − E will be negative—*i.e.*, the current will, as we know, pass from Q to P, and not from P to Q, although P is at a higher potential than Q.

To take another example, let us suppose that a dynamo is charging a set of secondary cells. Let V be the potential difference at the terminals of the cells, E their E.M.F., and b their resistance. The current going into the cells is $i = \frac{V-E}{b}$. So long as V>E, V − E is positive, and the cells are being charged; but if (owing, say, to a lowering of the speed of the dynamo) V becomes less than E, V − E will be negative, and the cells are discharging through the dynamo, driving it as a motor.

The above examples will suffice to show that in applying Ohm's law to any circuit, or part of a circuit, a certain amount of discretion must be used. The whole of the E.M.F.'s present in the circuit, or that part of it which is being considered, must be taken into account.

26. As a final example, we shall consider the case of a circuit *in which the current is varying.* As has been already explained in Art. 24, the variations of the current call into play E.M.F.'s of induction, and these have to be taken into account in determining the current. It is useful to draw a distinction between the E.M.F. which is the primary cause of the current, and the induced E.M.F.'s which merely make their appearance when the current is undergoing variations. The first is generally termed the *impressed* E.M.F. At any instant, the following relation holds:

$$\text{current} = \frac{\text{impressed E.M.F.} + \text{induced E.M.F.}}{\text{resistance.}} \quad (18)$$

It is the *algebraical* sum of the E.M.F.'s that is understood in the numerator of the fraction on the right-hand side of (18). The induced E.M.F. may be either of the

* Based on a series of evening lectures delivered at the University College, Liverpool.

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same sign as the impressed E.M.F., or of opposite sign. The relation expressed by (18) is an extremely important one, and we shall frequently have occasion to use it.

27. It is necessary to say a few words with regard to the *power* in a circuit containing several E.M.F.'s. To begin with, suppose we have a circuit of resistance r, in which there is only one E.M.F., say E. The current is $i = \frac{E}{r}$. The rate of expenditure of energy is $E\,i$, or $i^2\,r$. The latter represents the rate at which heat is being produced in the circuit, and in this case the whole of the energy which is supplied by the source of E.M.F. is being converted into *heat*. Next, suppose the circuit to contain an opposing E.M.F., or counter E.M.F., of amount e. The current will now be $i_1 = \frac{E - e}{r}$, whence $E = i_1\,r + e$. The power is $E\,i_1 = i_1^2\,r + e\,i_1$. The first term, $i_1^2\,r$, represents, as before, the rate at which dissipation of energy takes place by heating of the circuit; the second term, $e\,i_1$, represents the rate at which energy is being absorbed by the source of counter E.M.F. This energy may either be *stored up* (as in the case of secondary cells), or it may be converted into any other form of energy which undergoes immediate further transformations (as in the case of an electromotor). The whole of the power in the circuit may therefore be regarded as made up of two parts: one part going towards producing *heat* in the circuit, the other towards the transformation of the electrical energy into forms *other than that of heat*. When the current in a circuit is increasing, the counter E.M.F. induced in the circuit causes *storage of energy*, the form which the energy takes being that of a magnetic field. The magnetic field due to a current, in fact, represents so much potential energy, and we shall see presently how this energy may be determined.

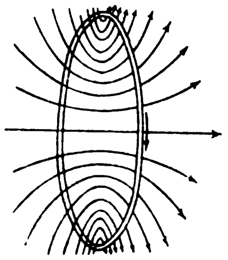

FIG. 16.

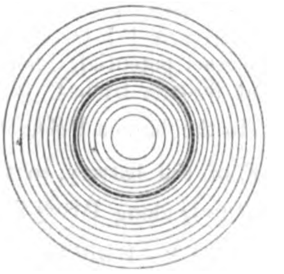

FIG. 17.

Considering next the most general case, in which we have a number of E.M.F.'s in a circuit of resistance r, let us suppose that the E.M.F.'s whose direction is the same as that of the current, i, are denoted by E_1, E_2, E_3 . . . , and the E.M.F.'s which are opposed to the current by e_1, e_2, e_3, etc. The E.M.F.'s E_1, E_2, E_3 etc., act as *sources* of energy; the E.M.F.'s e_1, e_2, e_3, act as absorbers or *sinks* of energy. The *current* in the circuit may be regarded as transferring energy from the sources to the sinks. But this transference cannot be accomplished without a certain amount of the energy being dissipated in the form of heat, the rate of dissipation being given by $i^2\,r$. We thus have the equation:

$$\underbrace{(E_1 + E_2 + E_3 + \ldots)\,i}_{\text{Total rate of production of energy}} = \underbrace{(e_1 + e_2 + e_3 + \ldots)\,i}_{\text{rate of absorption}} + \underbrace{i^2\,r}_{\text{rate of dissipation.}}$$

28. Consider a simple circuit conveying a current. A certain number of magnetic lines will thread themselves through the circuit, as shown in Fig. 16. It must be understood that the lines which we are considering are merely *those due to the current* in the circuit, and do not include any lines which may be due to the presence of magnets or other circuits conveying currents. We also suppose that the medium surrounding the circuit is air. We shall call the total number of magnetic lines (due to the current) passing through the circuit the *magnetic flux* through the circuit. This magnetic flux may be regarded as made up of two parts—viz., the lines which pass entirely outside the conductor forming the circuit, and the lines in the substance of the conductor. In Fig. 17 let the thick-line circle represent the section of the wire forming the circuit. The thin-line circles are supposed to represent the magnetic lines *due to the current*.* At the centre of the circle* the magnetic force is zero. As we proceed from the centre outwards the magnetic force gradually *increases*, reaching a maximum just at the boundary of the conductor; on receding from the boundary of the wire we find that the magnetic force *decreases*. In the case of many circuits the part of the magnetic flux which is confined to the substance of the conductor is but an insignificant portion of the total flux, but in other cases (more particularly in the case of iron wires conveying currents) it may be considerable.

29. Since we have supposed the circuit to be surrounded by air, it follows that the magnetic flux through it will be directly proportional to the current. Hence, if F stand for the total magnetic flux due to a current i, we may write

$$F = L\,i \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (19)$$

where L is a constant which is independent of i. The constant L is termed the *coefficient of self-induction*, or *inductance*, of the circuit. Since F becomes equal to L when $i = 1$, we may define the *inductance of a circuit* as *the magnetic flux through it due to unit current.*

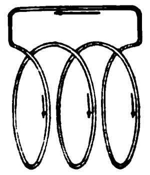

FIG. 18.

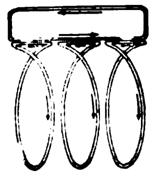

FIG. 19.

We have next to explain the meaning of the term "inductance" when applied to a complex circuit such as a coil of wire. The circuit represented in Fig. 18 is supposed to be made up of three loops In order to determine the magnetic flux due to unit current, we may imagine the complex circuit split up, as in Fig. 19, into a number of simpler circuits. The sum of the magnetic fluxes through the various simple circuits into which the complex circuit has been broken up gives us the total magnetic flux due to unit current, and this we define to be the *inductance* of the complex circuit.

30. If we imagine a coil the diameter of which is large compared with the dimensions of its cross-section, we can easily deduce an approximate expression for the inductance of the whole coil in terms of the inductance of a single turn. For in the case of such a coil we may roughly assume that the magnetic flux through each turn will be the same. Let l stand for the inductance of a single turn of the coil, and let there be S turns in the coil. Then, since a unit current through one turn causes l lines to pass through that turn, a unit current through the whole coil—*i.e.*, through S turns—will cause $S\,l$ lines to pass through *each* turn. Hence the total magnetic flux through the coil when conveying unit current—*i.e.*, its *inductance*—will be $S \times S\,l = S^2\,l$. We thus arrive at the result that the inductance of a coil varies approximately as the *square of the number of turns* in it

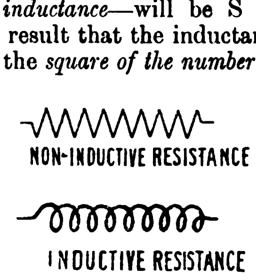

FIG. 20.

31. In the case of some circuits, such as a wire which is doubled back upon itself, the inductance is extremely small. Such circuits are usually called *non-inductive* circuits. It is impossible to obtain a circuit which is absolutely non-inductive, but the term is applied to circuits whose inductance may, for all practical purposes, be left out of account. By an *inductive* circuit we mean one whose inductance is appreciable. It is convenient to have special symbols for denoting non-inductive and inductive resist-

* This is only an approximation. It would be strictly correct for an infinitely long wire at a distance from all other conductors conveying currents.

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ances, the symbols in general use being those shown in Fig. 20.

A common form of non-inductive resistance consists of a wire doubled on itself. The magnetic field due to such an arrangement is represented in Fig. 21. The points of zero magnetic force O and O_1 are not at the centres of the two conductors (the outlines of whose sections are indicated by the thick-line circles), but are displaced outwards. Such an arrangement produces an external field, which, however, becomes extremely feeble as the distance from the conductors increases.

A more perfect arrangement is obtained by making one of the conductors a hollow cylinder which completely encloses the other. The lines of magnetic induction in this case consist of concentric circles, as shown in Fig. 22, and there is absolutely no field outside the conductors, the lines being entirely confined to the substance of the conductors (and the thin layer of insulation between them). Figs. 21 and 22 are both drawn roughly to scale, the conductors being supposed to convey the *same* current in each case. By counting the number of lines in the two cases, the student will see that the arrangement shown in Fig. 21 gives rise to about three times as many lines as that shown in Fig. 22.

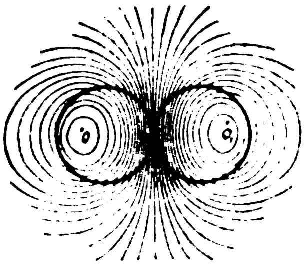

Fig. 21.

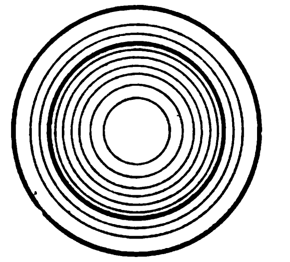

Fig. 22.

For all practical purposes, two conductors (of non-magnetic material) laid side by side—the one conveying the outgoing current and the other the return—may be regarded as forming a non-inductive arrangement. In many cases, in fact, a conductor forming a *narrow* loop (such as the filament of an incandescent lamp) may be considered as a non-inductive circuit.

32. Let us suppose that a steady E.M.F. is suddenly applied to an inductive circuit of resistance r. The current will not *suddenly* rise to its steady value, $\frac{E}{r}$, but will take an appreciable (though in most cases very short) time to do so. This is due to the fact, already explained, that as soon as the current begins to rise a varying magnetic flux is introduced in the circuit, and this varying flux induces an E.M.F. which opposes the current. While the current is growing, energy is being absorbed by the circuit in other ways than that of heat (Art. 27). What becomes of this energy? The answer is, that it becomes stored up in the form of a magnetic field surrounding the circuit. We shall now show how this energy may be calculated if the inductance L of the circuit is known.

Suppose N magnetic lines to be introduced during t seconds into a circuit in which a steady current of i C.G.S. units is maintained. The counter E.M.F. induced by the insertion of the lines is (Art. 23) $\frac{N}{t}$; hence the rate at which work is being done against the induced E.M.F. is (Art. 27) $\frac{N}{t} \cdot i$. The total amount of work done will therefore be $\frac{N}{t} \times i \times t = N\,i$ ergs. We thus have the following important result:

In increasing the magnetic flux through a circuit conveying a current i by N lines N i ergs of work are done.

From this we see that in order to build up the magnetic field of any circuit conveying a current, a definite amount of energy must be supplied to the circuit. We can easily determine this amount by the following method.

Taking the most general case of a circuit, in which the magnetic flux is *not* proportional to the current—*i.e.*, a circuit containing cores of magnetic material—let us suppose that the curve O B F D G (Fig. 23) gives the relation between the current in the circuit and the corresponding magnetic flux through the circuit. Let us suppose that at a certain instant the current has the value A B, and the corresponding flux the value O A. Let the current be made to increase by a *very small* amount, so as to assume the value C D; the magnetic flux will increase by the small amount A C. Since the length B D of the curve is supposed to be very small, we may regard it as a short straight line. The *mean* value of the current between A B and C D will then be given by E F, where E is such that A E = E C. Instead of supposing that the current steadily increases from A B to C D, we may assume that it has the constant mean value E F while the flux increases by A C. The work done in increasing the flux will then be, by the proposition just proved, A C × E F = area of A B D C, so that in increasing the current from A B to C D, and the flux from O A to O C, an amount of work is done which is represented by the area A B D C. The same result holds for every small increase of the current. Hence, the energy communicated to the magnetic field when the current rises from its zero value to the value H G is represented by the area O B G H.

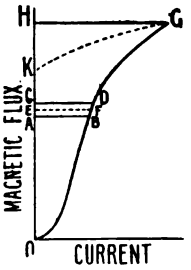

Fig. 23.

In the case of a circuit whose permeability is constant, the flux is simply proportional to the current, and the relation between these two quantities will be represented by a straight line, as shown in Fig. 24. Let us suppose that the inductance of the circuit is L. In starting a current i = A B in the circuit, we store up an amount of energy in the magnetic field which is equal to the area of the triangle O B A—*i.e.*, to $\frac{1}{2}$ L i^2 (since A B = i, and O A = L i). Hence,

The energy stored up in the magnetic field of a circuit of inductance L conveying a current i is $\frac{1}{2}$ L i^2 ergs, L and i being measured in C.G.S. units.

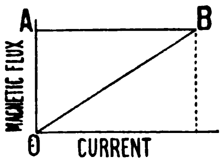

Fig. 24.

When the current is arrested by breaking the circuit, the potential energy of the magnetic field makes its appearance in the form of a spark. In the case of a circuit whose permeability is constant, the *whole* of the energy is returned at the instant of breaking the circuit, since all the magnetic lines which were produced by the current disappear on breaking the circuit. But when the magnetic flux passes through a substance exhibiting *hysteresis* part only of the energy is recoverable. Thus, if in Fig. 23 the dotted curve G K represent the descending branch of the hysteresis curve, the energy which is returned by the circuit when the current is arrested is represented by the area G K H. The area O B G K represents the energy dissipated *in the magnetic substance* by heating of the latter. If we suppose the magnetic substance carried through a complete cycle, we see that *the energy dissipated is represented by the area of the hysteresis loop.* The abscissæ of the loop, it must be noted, represent *current*, and the ordinates magnetic flux.

Since the energy stored up in a circuit of given inductance is proportional to the *square* of the current, it will be

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readily seen why the destructive effect of a spark increases very rapidly with the current. Thus, by increasing the current tenfold, the destructive effect of the spark is increased a hundredfold.

The *practical* unit of inductance is termed the *henry*, and it is equal to 10^9 C.G.S. units. In order, therefore, to determine the magnetic flux in C.G.S. lines through a circuit of inductance L *henries* conveying a current of *i amperes*, we must multiply the product $L\,i$ by 10^8 ($=10^9 \times 10^{-1}$), and in order to determine the energy stored up in *ergs*, the product $\frac{1}{2}\,L\,i^2$ must be multiplied by 10^7.

In most cases occurring in practice the inductance of a circuit is expressed by a small fraction of a henry.

(To be continued.)

RAILWAY BLOCK SIGNALLING.

BY J. PIGG.

(Continued from page 39.)

Instruments of the second division are subject to a class of disturbance which does not affect those of the first division. In consequence of the generally lighter construction and greater sensitiveness of the former, they are affected to a much greater degree by the presence of earth currents or the occurrence of "magnetic storms." Whilst the latter class of disturbance are of rare occurrence and never for prolonged periods, the former are nearly always present, and the selection of an earthing point which will allow of the block indicators keeping their normal position exactly is frequently a puzzle of no mean order. Earths which are made within a few yards of each other often give quite different results, and combinations of different earths will often give results which cannot be obtained from any of them separately. Moreover, there is no certainty that uniform results will be obtained from any earth or combination of earths which on being first connected are found to work satisfactorily; indeed, it is no uncommon experience for them to change before the man leaves the place.

At places where the earth connection has to be made in rocky or sandy soils, the resistance to earth is sometimes considerable, and "contact" between the different instruments ensues. It is not always possible to obviate this defect by utilising the rails as the return, more especially during dry weather and in places where junctions intervene. The remedy for these defects is obvious, and consists in diminishing the sensitiveness of the block indicators, and since "the movements of the block instruments and bells must be made slowly and distinctly," there is no necessity for so great a degree of sensitiveness in instruments as block working.

The relative cost for construction and maintenance of the three-wire continuous-current and the one-wire transient-current systems is a subject upon which, as has already been stated, considerable emphasis has at different times been laid. Where the instruments for use with one line wire are not overweighted with patentees' royalties there can be no doubt of the smaller cost for construction, and, other things being equal, for maintenance also. But it should not be forgotten that a complete block section includes, besides the electrical equipment, the lines themselves, the necessary buildings, and the mechanical signals and points, with their interlocking mechanism, and that of these items the electrical is probably the least expensive. Hence, the *difference* in the cost between a three-wire and a one-wire system is likely to be an almost inappreciable fraction of the *total* cost of the section, and this is rendered still more apparent when it is considered that the most expensive item of the electrical equipment—the construction of the pole line—is invariably used for other purposes than block working proper.

Hence, whilst it may be said that block circuits using one line wire and transient currents may be somewhat cheaper to maintain than circuits requiring three wires and continuous currents, yet the difference is small, and its importance is discounted by the greater variety of signals that may be used on the latter without an unnecessarily intricate code; the additional indication provided between the acceptance of the "Is line clear" signal and the "Train entering section" signal; the greater certainty of the indicators being in accordance with the conditions under which the line is worked when a defect exists in the block apparatus; and the self-testing character of the apparatus used.

The simplest case of block working is shown in the diagram (Fig. 9), in which the cabin, A, is an intermediate point between two others of more importance. Such a

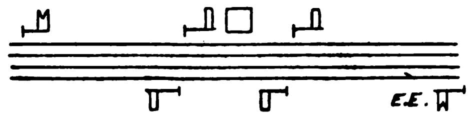

Fig. 9.

cabin is a mere passing place, and is only of use for shortening what would otherwise be too long a section for the amount of traffic passing, and is generally to be found in connection with some road crossing, or at a point near distributing sidings, or for stopping trains at a conveniently situated point to a junction where two or more lines converge. The next case in order of importance is shown by Fig. 10, where a relief siding is provided into which a train may be shunted in order to allow more important trains to pass. Fig. 11 shows a junction where three lines converge, and Fig. 12 shows a particular case where the lines connecting junction points form a triangle.

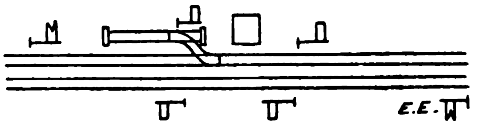

Fig. 10.

The diagrammatic representation of the wires and instruments for such cases as Figs. 9 and 11 are shown in Figs. 13 and 14 respectively.

The case represented by Fig. 12 introduces the 400 yards rule by which signalmen, in cases where the distance

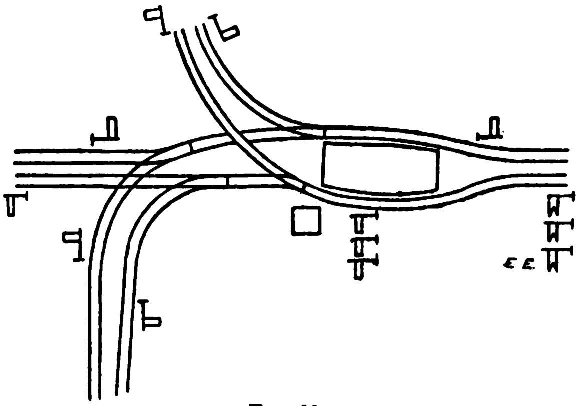

Fig. 11.

between successive cabins is 400 yards or less, must, before accepting the "Is line clear" signal from the rear cabin, obtain its acceptance from the advance cabin.

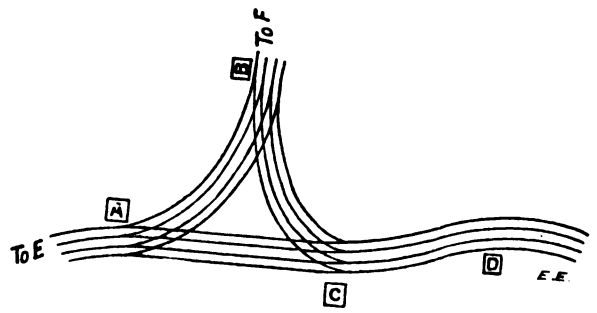

Fig. 12.

The arrangement of apparatus for the case represented by Fig. 12 is given by Fig. 15, and is peculiar for the

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means taken to obviate accidents likely to arise from local conditions. In general, however, the difference between an ordinary section and one under the 400 yards rule is in

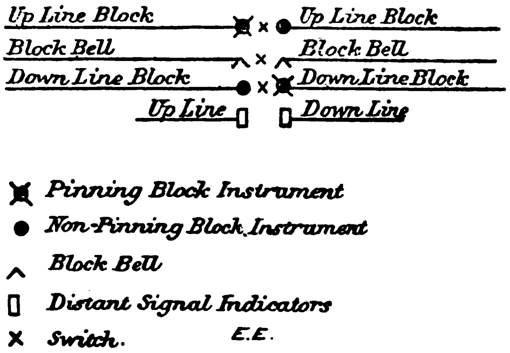

Fig. 13.

the rule for the acceptance of the "Is line clear" signal only, and does not involve any difference in the apparatus.

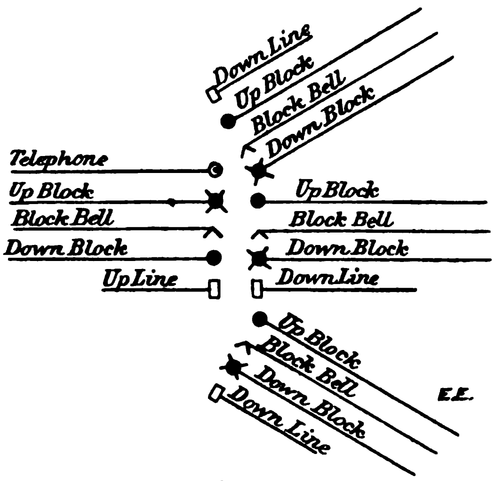

Fig. 14.

In the case under consideration the "down" line between E and D is on a falling gradient, and passes through a long tunnel between E and A. The block cabins, A, B, C, and D, are each within 400 yards of the next, and the acceptance of an "Is line clear" signal by A for a train passing to D is conditional upon its acceptance by both C and D, the latter being offered the "Is line clear" signal by C before accepting it from A.

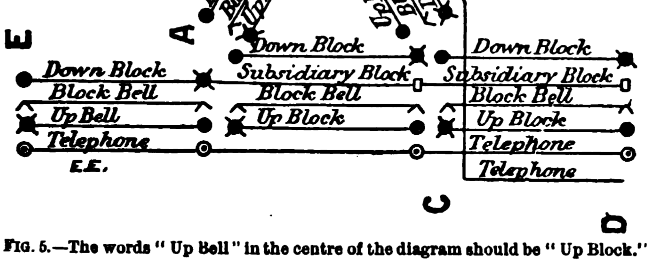

Fig. 5.—The words "Up Bell" in the centre of the diagram should be "Up Block."

Hence, before a train can leave E for D the line must be quite clear to the latter point, or through three sections, and in order that A may not accept a train from E without the knowledge of C and D, the "down" line instrument circuit between E and A is continued through indicators fixed in C and D, which reproduce at those places the indications of A's "down" line instrument at any time. Hence there are two independent checks on A's actions in accepting an "Is line clear" signal, and the indications are also of considerable value to C and D for the regulation of traffic to and from the section C B.

CONVERSAZIONE OF THE INSTITUTION OF CIVIL ENGINEERS.

The Institution of Civil Engineers have this year again taken up their old practice of holding conversaziones to which ladies are admitted. The number of members wishing to view the new buildings and to be received by the president of the institution was so large that two nights had to be taken to prevent undue crowding. The two evenings selected were July 15 and 16, and the night to which any individual member was invited to attend was determined by ballot. We were privileged to be present at the first evening's entertainment. The whole of the new buildings of the institution were most extensively decorated for the occasion with muslin draperies, flowers, and palms. We noticed a large number of celebrities present, of whom, of course, the electrical engineers formed a minor part, but such men as Lord Kelvin, Prof. Ayrton, Mr. W. H. Preece, Mr. Alexander Siemens, Prof. Kennedy, and Dr. John Hopkinson represented this branch of the profession. The entertainments were carried out in the whole of the rooms, the architecture of which were much admired by the guests.

An excellent programme had been arranged for the entertainment of the visitors. Prof. Roberts-Austen, C.B., F.R.S., with the aid of a lantern and an electric furnace gave a demonstration of the utility of electricity in melting certain refractory metals. Mr. Alexander Siemens and Prof. J. Norman Collie gave exhibitions of views illustrating their recent journeys, the former to the River Amazon and the latter through the Himalayas. The Röntgen rays, of course, proved very attractive, and the two rooms where this latest wonder could be seen were always crowded. Mr. Campbell Swinton in one room showed the results he had obtained with the rays, and in the other room Messrs. Siemens gave practical demonstrations with the rays and with vacuum tubes.

Another distinct feature was the exhibition of paintings, many of which had been lent, and many of which are the property of the institution.

There was an interesting display of models and scientific apparatus akin to the profession, and these were inspected with the greatest interest. The Royal Ordnance Factories exhibited specimens of electric welding of steel tyre bands and two sections of the barrels of 4·7in. quick-firing guns, illustrating the difference between the erosion caused by gunpowder and by cordite. The diving helmet shown by Mr. W. A. Gorman, A.M.I.C.E., attacted considerable attention. It was fitted with electric light and loud-speaking telephone. Messrs. Siemens Bros. had several exhibits, among which were a model of electric steering gear, tubular bearings reducing friction to a minimum (especially applicable to tramcars), samples of joints in non-hygroscopic lead-covered cables, and samples of the Amazon Company's sub-fluvial cables, showing river cable, shore end, and underground cable in trenches. Dr. Alex. Muirhead had a syphon-recorder at work with automatic curb transmitter, receiving messages through artificial cable equivalent to 3,000 knots. In the upper part of the staircase well we noticed two of Messrs. Drake and Gorham's "Jandus" arc lamps.

The music was exceedingly enjoyable. The string band of the Royal Artillery played during the evening, and no higher words of praise than the mention of their name can be uttered, unless, perhaps, one notes the fact that Cavaliere L. Zavertal, R.A., conducted. The vocal music was under the direction of Mr. William Coates, and consisted of madrigals, glees, and part-songs. The artistes were Masters Every, Cooper, Thomas, and Young, and Messrs. George May, Ernest Taylor, Harper Kearton, Charles Edwards, Wm. Coates, R. De Lacy, and George Stubbs, and their singing charmed everybody.

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THREE-WIRE PATENT.

On Wednesday the Judicial Committee of the Privy Council decided "not to report to her Majesty in the way which was necessary for a prolongation of the patent." The patent referred to is that of Dr. Hopkinson's, best known as the "three-wire patent." The reasons for this adverse decision are to be given at a later date, but we presume our readers do not care much about the reasons so long as they know the result. It greatly surprised us to learn that many people feared a prolongation of this patent, as in our opinion there never was any valid reason put forward in support of that course. The main facts are extremely simple when the legal, sentimental, and commercial addenda are stripped from them. Dr. Hopkinson patented a system of distribution which has been largely used. He sold his interest in this patent to a company, and so it must be at once and finally accepted that he was in his own estimation adequately paid for his work. The company that bought the patent, finding it valuable, naturally desired a prolongation. The directors would not be human if they did not wish to continue a certain source of income as long as possible. In our opinion, however, neither legal forms, sentimentality, nor morality justify the extension of a patent when the inventor has been pecuniarily satisfied for his work. The company did not buy this patent with the idea of recouping itself after the lapse of the patent, but with the idea that it would be amply repaid before such lapse. Of course it was worth while going for an extension, inasmuch as no one is absolutely certain what view judges will take; and if on the off-chance that view prove favourable to the company, a stake would be won that was certainly worth trying for. Surely, however, the ordinary conditions of patent law are satisfied with the one point, "the inventor is satisfied." It ought not to consider the wishes of a speculative company desirous of exploiting something to its own advantage and not to the advantage of the inventor. If Dr. Hopkinson had never sold his interest, and had depended upon the return from royalties during the life of the patent, and these royalties had been unsatisfactory through the necessity in the first place to get a public who understand the value of the patent, and in the second, to the lack of enterprise by that public in using the patent, the question would have had to be approached in a different manner. In this particular case the inventor has been satisfied, and though the company naturally wants more, it has not done badly. There is another way in looking at these questions of patent rights and satisfactory remuneration, assuming the inventor to be the only party interested. Is his satisfactory remuneration to be calculated from what he would have been satisfied with in the early days of his patent — that is, should he put his value upon the patent when he takes out the patent, or should it be calculated from the consideration of the question towards the end of the period of the life of the patent? An inventor should be treated more than justly: he should be treated generously. It is largely his work that renders the progress of the world possible, and niggardliness to such men

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should be avoided. Ofttimes he is years before the world is ready for him, and then meets with the cold shoulder. In the particular case under notice the industrial world has recognised for a number of years the value of the patent, and the inventor was at any stage of its life capable of looking after his own interests. The decision, then, may be looked upon as unavoidable, and probably when the reasons of the judges are known, they will be found to be merely an amplification of the view that, the inventor himself being satisfactorily remunerated, any exploiters must take their own risk.

ENGLISH APATHY.

In the Board of Trade *Journal* for the present month will be found an extract from our Consul at Bilbao. It contends that we are losing business because of our lack of enterprise. We take the most effective way we possess to bring these remarks before our readers. Just as we have recently sent a representative to Germany, we hope next month to send to Bilbao, after which no doubt a better opinion can be formed on this matter. The following is the extract referred to: "Her Majesty's Consul at Bilbao says that electricity is daily more used in that district. The light is used in streets, in villages, on the river, and in many houses; an electric tramway has been laid down from Bilbao to Santurce, and another one is under construction down the right bank of the river. But the names of British firms are not noticeable on any of the apparatus. None of it is made in Spain: all has to be imported, so that there is a field for competition. The only thing is that Germans have got the start. It might be well worth the while of British firms to try whether they cannot secure part of the business. Even if they cannot compete in price, it is to be hoped that they can excel in quality, and it may be observed that as regards price the Germans are handicapped by the payment of a heavier duty. If these remarks meet the eye of electrical plant manufacturers, they will—that is, the more enterprising ones, unless they are different from other manufacturers—write to ask for lists of firms to which they may send their price-lists, which are made out in English. The answer would be that a list of firms will be found in the 'Libro de Bilbao,' published by Larrañaga y Lejarcegui, Calle de Ledesma, No. 22, Bilbao, who will send it post free for 3s., but that it is far the best plan to send a traveller. The fact is, that a traveller is almost necessary when it is desired to supersede an article already in possession, but unfortunately the use of travellers never seems to commend itself to British firms."

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

CENTRAL-STATION STAFFS.

Sir,—During the recent meeting in London of the Electrical Association a paper was read on the organisation of the engine-room staff. Now, the smooth working of a station depends on the order and management. It is only right and proper that the chief engineer should have absolute control of all his staff, that he should have the authority to appoint or discharge any man in the station, no matter whohe may be. It is a grave error for committees to make appointments. If a committee trust their engineer, why not let him choose his own men? Surely he is the best judge in these matters, seeing he is responsible for the working of the station. During the discussion following this paper a gentleman mentioned a case where the chief engineer was annoyed by his assistant, who, being appointed by the influence of a committee member, thought he could snap his fingers at his chief. This is not right; let the engineer have absolute power. In every station there should be two departments: mechanical and electrical. The engineer should have charge of the engine-room and stokehole, the electrician the charge of dynamos and switchboard, both men being under the charge of the chief engineer. In stations, however, the assistant engineer (who in nine cases out of ten knows as much about engines as the man in the moon) is looked up to with reverence, and "Mister" prefixed his name, while the engineer proper is contemptuously termed an "engine-driver," and is plain Smith or Jones, etc. Red-tape "won't wash," though—the colour comes out. Take, for instance, a lad. He serves his time with an electrician. When out of his time he applies for an assistant's berth in a central station. He obtains it. He has charge of the whole of valuable machinery, mechanical and electrical. He might have a fair knowledge of electricity, but what on earth does he know about engines and boilers? The engine-driver must stand by and be told how to do his work by a boy of 21, who perhaps had charge of engines before the other was breeched! It stands to reason that a young man cannot be efficient in both trades. Of course, an older man having had experience both ways is competent, but the majority are youngsters. Engines are as important as dynamos.

These appointments should be made according to Board of Trade rules, which should compel the candidate to produce certificates of competency in both branches. As a member remarked during the late meeting, central stations were in a good many cases training schools at the expense of the corporation.

Corporations make a grand mistake in appointing men who are electricians only, but no doubt they are ignorant of the risk they run. As long as the engines and boilers work all right the assistant gets the praise; but in the case of mishap, who is blamed? Not the assistant. I think it is time now that attention was called to this.

Trusting that I have not monopolised too much of your valuable space, and thanking you in anticipation—Yours, etc., Fair Play.

CHOKING COILS AND ARC LAMPS.

Sir,—My attention has been called to a criticism on my interview with Mr. C. P. Feldmann in a contemporary of the *Electrical Engineer*. The editorial comment is to the effect that when Mr. Feldmann says "voltage," he means current. The description is that of a system of arc lamps with choking coils in series, and the sentence in question is as follows: "If from any cause the lamp goes out the choking coil immediately takes up the whole current of the circuit, and at the same time keeps the voltage constant." Mr. Feldmann kindly added a note to explain how a choking coil when properly designed could do this. I regret that the editor of the contemporary in question has not enough technical knowledge to understand this simple deduction from Ohm's law, and should throw doubt on Mr. Feldmann's statements. Under the circumstances it would be better if he confined his criticism to the language and motives of vestrymen, of which in the first part of the same issue he shows himself to be fully conversant.—Yours, etc.,

Your Special Correspondent.

James Eadie, Limited.—This Company, which has been started with a capital of £500,000, takes power to construct and maintain, among other things, electric works.

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THIRD RAIL ON THE NANTASKET BEACH ROAD.*

The second step toward the operation of its main lines by electricity was made June 26 by the New York, New Haven, and Hartford Railroad Company in the extension of the electrical equipment of the Nantasket Beach line as far as East Weymouth, 3½ miles along the main line of the South Shore branch of the Plymouth division, of which Mr. J. C. Sanborn is superintendent.

In determining upon this extension the overhead trolley system in use on the Nantasket Beach branch was abandoned and the third-rail method of contact chosen as the most readily adaptable to ordinary railroad requirements. While the third-rail system for electric roads is not new, it being in use on the West Side and Lake-street elevated railways in Chicago, the rail being set outside the track, this is the first instance of a third rail being laid upon the permanent way of a trunk steam road, between the rails of the service track.

The current for the third-rail section is brought from power-house No. 1, on the Nantasket line, over two insulated feeders of copper cable laid along the tops of the poles which carry the overhead wires of the Nantasket line. At the Nantasket Junction station the feeders are dropped to the ground, and each is connected to its own third rail.

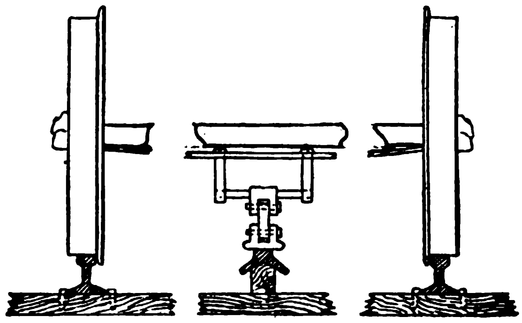

Fig. 1.

The third rail is of peculiar shape, the end view resembling a flattened A (Fig. 1). It is laid midway between the two service rails of each track. Each section of third rail is 30ft. long, and weighs 93lb. to the yard. It is supported by three ash blocks to each section, the blocks being let into the ties. Before use these blocks are boiled in vacuum pans with a tar compound, and thus each pore is filled with insulating and preservative material. The insulation is almost perfect. The continuity of the third-rail circuit is secured by attaching each end of one rail to that of the next by means of two heavy copper bonds. The line between Nantasket Junction and East Weymouth is absolutely distinct electrically from that between the first-named stations and Pemberton. It is fed by its own feeders and is provided with its own automatic safety appliance which, in case of carelessness or accident to the third-rail section, enter into action and cut all current off from it, rendering it nothing more than a peculiarly laid stretch of track.

The electricity is taken from the third rail by two sliding shoes (Fig. 2) hung loosely from the car, one suspended between the axles of each truck immediately under the king-pin by two links, which allow it to slide easily over the top of the third rail and make perfect contact with it all the time. The current is brought to the motors through the controllers and circuit breakers, and returns to the track rails by the wheels. The continuity of the return circuit is secured by using a short, thick bond of copper cable to join together the ends of each pair of track rails, the ends of the bond being fastened into the flange of the rail. The distance between each of the two shoes on the car is 33ft. No third rail is laid at the crossings, the circuit continuing between the broken end by means of lead-covered cables. At the crossings, less than 30ft. wide, one of the shoes is always in contact; at wider ones the inertia of the moving car brings the shoes into contact again before the car can come to rest.

* From the *Electrical Engineer* (New York).

The baggage-cars in use last year, each equipped with four motors, have been abandoned, and the large 16-bench open cars are alone employed as motorcars or locomotives. Sixteen of these cars will be put into service, each equipped with two General Electric "2,000" motors, two series-parallel controllers, two automatic circuit breakers—the safeguards from accident to the rest of the electrical apparatus—and an air-pump and motor for the compressed air for the whistle and brakes. The air-pump combination is automatic in its action. As soon as the pressure in the main air-tank falls below 90lb. to the square inch a small knife switch is closed by a spring and the motor starts. The switch is forced open by the air pressure as soon as that in the tank reaches the normal.

The cars leave Pemberton and run with the trolleys as far as Nantasket Junction. The trolley is then pulled down and hooked, and the shoe strikes the third rail, the passengers being unaware of the change in the method of contact. The regular schedule of the electric trains between Pemberton and East Weymouth has been in force since June 14, but owing to the non-completion of the third-rail section the trains have been hauled from Nantasket Junction to East Weymouth, 3½ miles, by two steam locomotives.

A good idea of the advantage of electricity as a motive power compared with steam may be gathered from the fact that the two locomotives burn each four tons of coal per day, while not more than four tons per day burned in the power-house serves to generate sufficient power to operate the whole seven miles of line between Pemberton and Nantasket Junction by electricity. The construction of the new section has been carried out under the personal supervision of Colonel H. H. Heft.

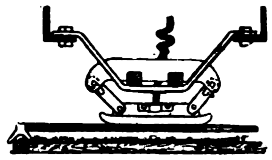

Fig. 2.

During a recent test with the officials of the railroad on board a speed of from 70 to 80 miles an hour was attained. On arrival at East Weymouth the car was switched over, and the return trip was made from East Weymouth to Pemberton in about 11 minutes, the distance being about 10½ miles. Should the operation of this road prove successful, it is probable that the third-rail system will be extended as far as Braintree, a station 10 miles out of Boston, and if the success of the new method under the ordinary conditions of constant travel fulfils all expectations suburban service throughout the country will probably undergo a change.

ALTERNATE-CURRENT TRANSFORMERS.*

BY DR. J. A. FLEMING, F.R.S.

LECTURE I.

The Action of the Transformer.

In the last 10 years the alternate-current transformer has been developed from an experimental instrument into a practical appliance of immense utility. According to recent statistics, there are at present about 50 alternating-current electric supply stations in the United Kingdom, supplying not less than 1,100,000 8-c.p. lamps. This amount of lighting requires the expenditure of 54,000 h.p., or 40,800 kilowatts at full load, and hence there must be transformer capacity in the United Kingdom at the very least equal to 40,000 kilowatts. These transformers, as presently to be explained, all contain an iron core, which has to be magnetised and demagnetised 200 times a second, or 6,000,000 times a year. The total weight of iron cores in the whole of these transformers will be certainly not less than 400 tons, and it will require at least 400 kilowatts to maintain the magnetisation of these cores. If these transformers are connected with the circuits only, on the average, 4,000 hours a year, it is very easy to see that the magnetisation of the cores of the transformer will require not less than 1,600,000 Board of Trade units spent per annum, and this means at least 16,000,000lb. of coal, or 8,000 tons. Hence, in the United

* Cantor lectures delivered before the Society of Arts

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Kingdom, we have buried away somewhere or other at least 400 tons of iron forming the cores of transformers, and these involve at least an expenditure of 8,000 tons of coal, costing some £6,000 sterling to maintain that magnetisation. It is, therefore, easily seen that the study of the construction of the alternate-current transformer, and its possible improvement, is one which is not at all unimportant from an engineering point of view.

I propose to assume in these lectures that the majority of those present are acquainted with the principal facts connected with the flow of alternating currents of electricity in inductive circuits, and to address myself more particularly to the study of alternating-current transformers from a practical point of view, discussing in the four lectures of this course the action of the transformer, the construction of the transformer, the testing of the transformer, and the employment of the transformer. You are all probably aware that an alternating transformer in its simplest form consists of two circuits of insulated wire, which are wound upon an iron core, and that this device operates to transform electric energy in such fashion that the flow of an alternating current through one circuit is made to produce another current in the second circuit, with an increase or decrease of current strength taking place at the expense of potentials. The transformer does no more than any lever, wheel and axle, or simple machine in transforming power from one form into another form. The general operation of the transformer or induction coil, in whatever form it may be taken, is then as follows: Through one of the circuits, called the primary circuit, is passed an intermittent, interrupted, or alternating current. This primary circuit is interlinked with a magnetic circuit, and the primary circuit establishes in the magnetic circuit an intermittent, interrupted, or alternating induction; the magnetic circuit is interlinked with a secondary circuit, and the variation of magnetic induction in the core creates an E.M.F. in the secondary circuit, which at any instant depends upon the rate of change of the total induction linked with the secondary circuit.

As the word "induction" will very frequently be mentioned during the succeeding lectures, it is exceedingly important there should be no ambiguity in your minds as to the meaning of this term. We may help ourselves by regarding the analogy of conducting circuits and magnetic circuits. Consider a conducting circuit in which an electric current exists. As long as the circuit is closed we recognise the presence of the current, either by heat produced in the conductor or by electrolysis, and by various magnetic and dynamical actions in the medium round it. We select some one of these effects, say the electrolytic effect, and we base our quantitative definition of current strength upon it; thus, for instance, the accepted definition of an ampere is that it is a current which in one hour deposits, electrolytically, 4·025 grammes of silver. The cause, whatever its nature, producing the current is called the E.M.F. If we draw any line linked with or surrounding the conductor conveying the current, whether that line be included in a magnetic material like iron, or a non-magnetic material like air, we find a physical action taking place in that path which is called magnetic induction, and the immediate cause of this magnetic induction we speak of as magnetic force. We measure this induction by one of the effects it can produce—namely, by the E.M.F. which it can set up in another conducting circuit linked with the magnetic circuit when that induction is suppressed or reversed at a given rate. Faraday showed that the proper measure of the total magnetic induction linked with any conducting circuit was the total quantity of electricity set flowing in the circuit when the magnetic induction is suppressed or reversed. In practical work it is better to abandon the rather academic phrase, "number of lines of force," or induction, so much used, and to think of the induction as a physical effect produced in the magnetic circuit, its value being reckoned in webers, the induction being produced in the magnetic circuit by magnetic force, just as electric current reckoned in amperes is produced in the conducting circuit by E.M.F. Hence we have this definition of a unit of magnetic induction. A unit of magnetic induction, called one weber, is an amount of induction which, when linked or unlinked with a circuit of one turn, and having a resistance of one ohm, causes one coulomb of electric quantity to flow round the conducting circuit. Generally speaking, if induction is measured in webers (one weber $=10^8$ C.G.S. units), we have the following relation between the magnetic induction, the number of turns or linkages which the secondary circuit makes round the line of the induction, the resistance in ohms of the secondary circuit, and the total quantity set flowing in the secondary circuit reckoned in coulombs.

Webers × linkages = coulombs × ohms.

Since one weber is a larger amount of induction than is met in any single transformer core or dynamo magnet, it is convenient to take the millionth part of this as the practical unit—viz., the *microweber*, and to commit to memory the following rule: microwebers × linkages = microcoulombs × ohms, and to recollect that one microweber is equal to 100 C.G.S. units of induction, or what would commonly be called 100 lines of force. In order to measure induction we require, then, a ballistic galvanometer as a practical instrument to measure electric quantity; and we can at once make a measurement of the induction in any magnet circuit by determining the quantity of electricity set flowing in a circuit of a known number of turns which is linked with this induction and then unlinked by withdrawing the circuit or reversing the induction. As a practical illustration of these methods it will be useful to make a measurement of the induction existing in this closed iron ring when it is magnetised by a current flowing round it. The ring, as you see, is wound over closely with one layer of wire, which we will call the primary circuit. If we measure the mean perimeter of the ring and count the number of turns, it is a simple matter to obtain the number of turns per centimetre. If a current measured in amperes is set flowing through this circuit, then it can easily be shown that the magnetising force acting upon the iron is equal to $1\frac{1}{4}$ times the turns of wire per centimetre, multiplied by the ampere current flowing through the circuit.* This magnetising force produces in the iron a certain magnetic induction which is measurable in microwebers. In order to find out the magnitude of this induction, we put upon the ring a secondary circuit of a known number of turns. We then employ a ballistic galvanometer suitable for measuring electric quantity, and we must first calibrate this ballistic galvanometer to determine the excursion or throw of the needle when a given quantity of electricity measured in microcoulombs is sent through it. This is most easily done by charging a condenser of half a microcoulomb by means of a standard cell having an E.M.F. of 1·5 volts, and discharging this quantity of $1{\cdot}5 \times {\cdot}5 = \frac{3}{4}$ microcoulomb through the galvanometer. This produces a certain throw or excursion of the needle, and we may then assume that for any other throw of the needle the quantity of electricity producing it is proportional to the throw as determined by the above calibration. In order to measure the magnetic induction in the iron circuit, all that we have to do then is to connect the secondary circuit having a known number of turns, and the resistance of which, added to that of the galvanometer and connecting wires, must be determined in ohms, and observe the throw of the galvanometer needle, which is produced when the primary current is reversed. Ascertaining

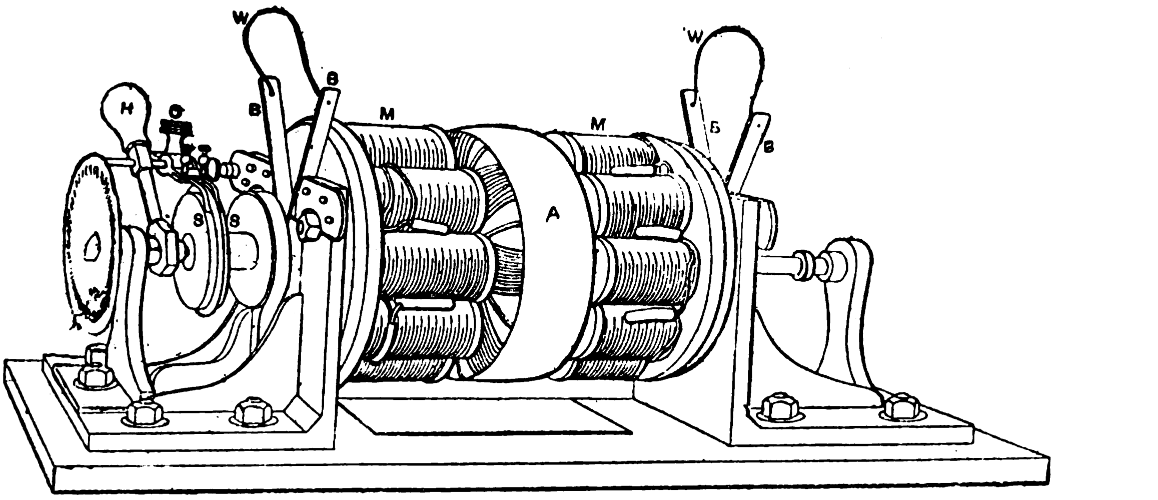

Fig. 1.

* *Vide* "The Alternate-Current Transformer," Fleming (new edition), vol. i., p. 23.

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from the previous calibration the electric quantity measured in microcoulombs represented by the throw, we multiply that number by the total resistance of the secondary circuit, including the galvanometer, measured in ohms, and divide the product by the number of linkages or turns of the secondary circuit. This quotient gives us double the induction measured in microwebers existing in the iron core at the time when the steady current is flowing through the primary circuit, hence the induction is at once measured in microwebers.

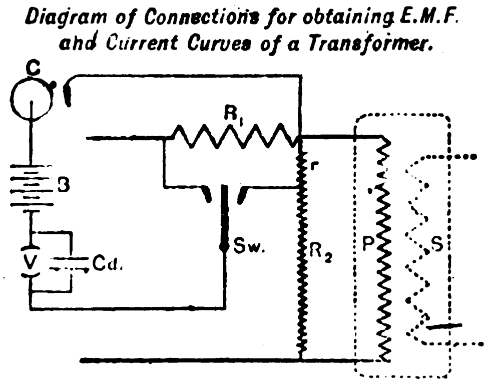

Fig. 2.

Returning then to the alternate-current transformer, we may classify transformers, converters, or induction coils, as they are also called, according to their construction and their use as follows: transformers may be (*a*) iron-core transformers, with a core wholly or partly of iron; (*b*) air-core transformers, with a core or magnetic circuit wholly of non-magnetic substance. Iron-core transformers may be (*c*) closed iron circuit transformers, with a magnetic circuit wholly of iron; (*d*) open iron circuit transformers, with a core partly of iron. Transformers may be

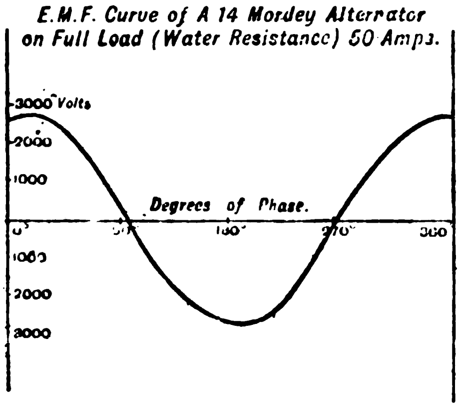

Fig. 3.

used (*e*) to transform a potential difference in a constant ratio, in which case they are called constant-ratio transformers; (*f*) to transform a current strength in a constant ratio, in which case they may be called constant transformers. The transformers may be employed (*g*) to raise pressure or current, and they are then called "step-up" transformers; (*h*) to lower pressure or current, and then they are called "step-down" transformers. This is not an exhaustive classification, but it is sufficient for practical purposes. By far the most important member of the group is the constant-potential closed

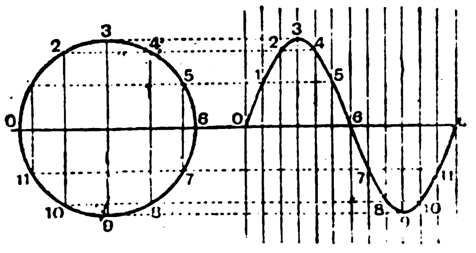

Fig. 4.

iron circuit transformer employed with alternating currents taken from a constant-potential primary circuit. This may be considered from its importance to be the chief of the clan, and to it, therefore, we shall pay most attention. In order to possess a complete knowledge of the operations and action of such a transformer, we require to know the nature of the operations going on in all parts of it at the same instant. We have seen that the broad general action of the transformer as employed with alternating currents is as follows: if an alternating primary current is passed through the primary circuit it acts upon the iron core with an alternating magnetic force, and creates in the iron core an alternating magnetic induction. If a secondary circuit is also wound round the same iron core, the periodic variation of magnetic induction in the magnetic circuit creates a periodic E.M.F. in the secondary circuit, and if that circuit is closed, creates in it a periodic secondary current. The method which of late years has proved most fertile in adding to our real knowledge of the subject of the

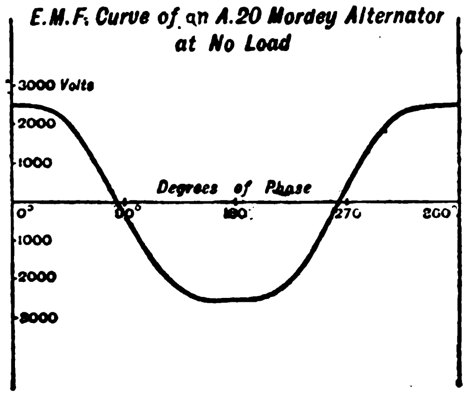

Fig. 5.

transformer is that of delineating graphically the various periodic quantities concerned by a process which is called alternate-current curve tracing. It is, therefore, necessary to study this process in some detail. Suppose that we have an alternating-current dynamo or alternator in operation we know that the potential difference between the terminals of this machine undergoes periodic variation, and that it passes from one maximum in one direction to another maximum in an opposite direction. At any instant the machine is producing an

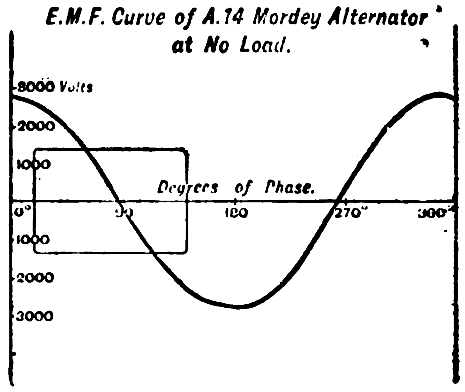

Fig. 6

E.M.F. which is called its instantaneous value. Suppose that the alternator terminals are connected to a condenser, the potential difference of these condenser plates follows the same law of variation as the E.M.F. of the machine. If the condenser is removed at any instant and the potential difference

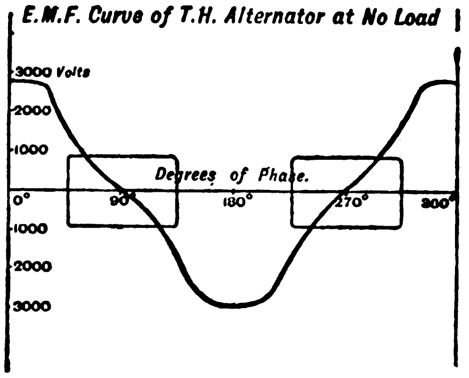

Fig. 7.

of its plates examined, that will give us the potential difference of the terminals of the alternator or the E.M.F. of the alternator at the instant when the condenser was disconnected. The practical arrangements made for doing this which I have found it convenient to use, are as follows: A small alternating-current motor (see Fig. 1) has its field magnets excited by a constant continuous current, and its armature traversed by a current coming from the alternator under examination. The shaft of this alternating-current motor carries an ebonite disc, on which is placed a small steel slip. As

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the disc rotates the steel slip passes at each revolution underneath two small steel springs, lightly touching the ebonite disc. The steel slip, therefore, electrically connects these springs (which are otherwise insulated) together, and this connection takes place at each revolution. The two springs are carried on an insulated bar, which is capable of being moved round an arc

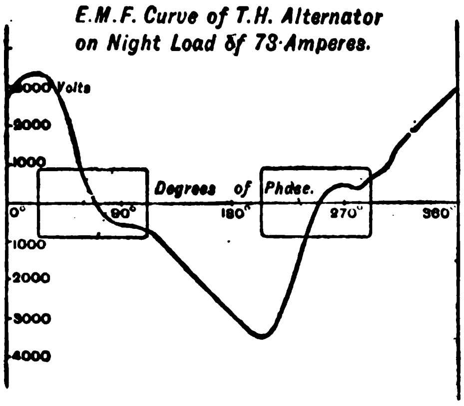
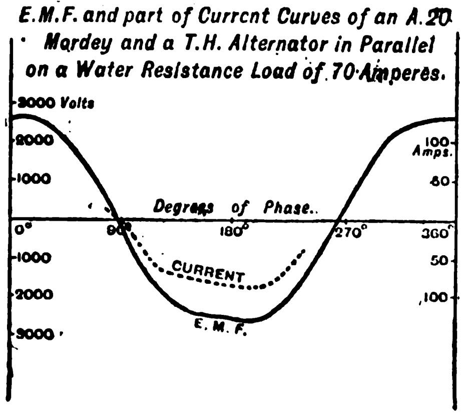


Fig. 8.

of a circle in such a manner that the instant when the springs are connected together can be altered and determined by the angular position of the rocking bar carrying the two springs as read off on a scale. If this little alternating-current motor is started in step with the alternating-current machine, it will keep in step with it, and will close the circuit of the two springs once during every revolution at an instant during the complete phase of the E.M.F. depending on the position of the springs.



Figs. 9.

These two springs, constituting the revolving contact breaker, are connected in series with a small battery of lithanode cells, B (see Fig. 2), and these again with an electrostatic voltmeter, V.

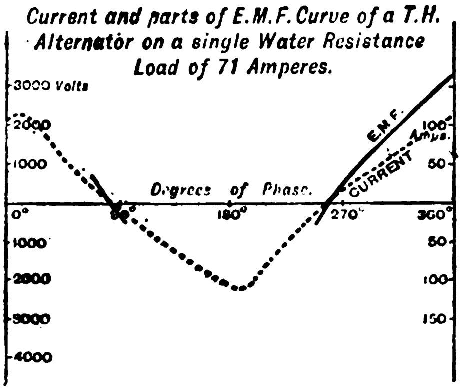


Fig 10.

across the terminals of which a condenser, Cd, is joined. This appliance may then be employed to determine the form of the curve of an alternating current or an E.M.F. as follows: Suppose it be desired to determine the curve of E.M.F. of any alternator, the contact-breaker is joined across the terminals of the alternator, and the reading of the voltmeter is taken as the rocking arm carrying the springs is moved round by steps through an angular interval corresponding to one complete period. At equal intervals during the movement the electrostatic voltmeter is read, and in order to bring the readings within the best part of the scale of the voltmeter a selected number of the cells of the battery, B, are placed in series with the voltmeter so as to add a known E.M.F. to the E.M.F. being measured.* By the employment of a revolving contact-breaker of this form, a number of curves were taken from the alternating-current machines in the City of London

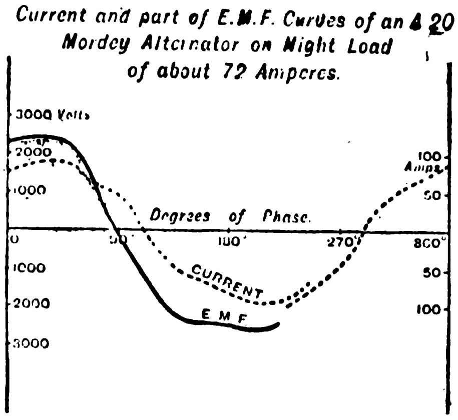


Fig. 11.

electric lighting station at Bankside, some of which are shown in the accompanying figures.

Fig. 3 represents the E.M.F. curve of a Mordey alternator on full load, the load being a water resistance. It will be seen that the curve of E.M.F. is not very far from a simple periodic or simple sine curve as shown in Fig. 4. Fig. 5 shows the E.M.F. curve of a larger Mordey alternator at no load, and Fig. 6 shows the manner in which the E.M.F. curve at no load is related to the position of the pole-piece represented by the rectangular line. The E.M.F. curve of an alternator is, however, not by

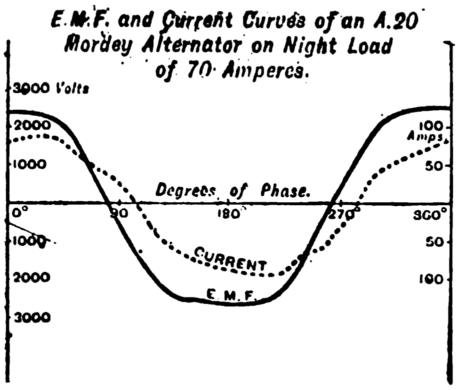


Fig. 12.

any means always so nearly a simple periodic curve. Fig. 7 represents the electromotive curve of a Thomson-Houston alternator taken at no load, the position of the field poles with respect to the E.M.F. curve being shown by the square

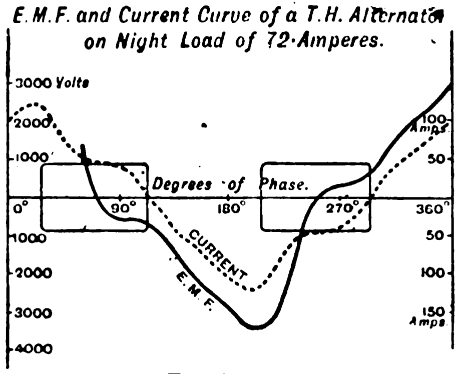


Fig. 13.

rectangles in the figure. Fig. 8 shows the E.M.F. curve of the same machine when working on a highly inductive load of transformers. In order to determine the form and relative position of the current curve, all that is necessary to do is to put in series with the alternator circuit a non-inductive resistance sufficient to carry without sensible heating the outgoing current. By connecting the revolving contact-breaker and associated voltmeter with the terminals of this non-inductive

* For further details see "The Alternate-Current Transformer," Fleming, vol. i. (new edition), p. 521.

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resistance, we can delineate the curve of fall of potential down the non-inductive resistance, which is identically the same thing as the curve of current in the resistance.

In this manner have been determined the current curves taken from the above-mentioned machines, both on inductive and non-inductive loads. Fig. 9 shows the E.M.F. curve and part of the current curve of a Mordey and Thomson-Houston alternator on a water resistance; and Fig. 10 shows the current curve and part of the E.M.F. curve of a Thomson-Houston alternator working on a water resistance. These diagrams show that when an alternator having an E.M.F. of 2,000 volts is working on a water resistance this load is an absolutely non-inductive load, the current curve being practically perfectly in step with the E.M.F.

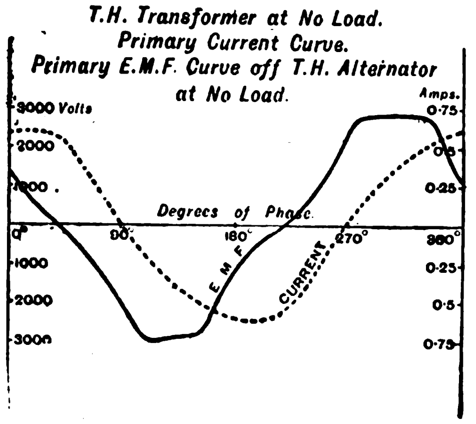

FIG. 14.

This leads to the conclusion that in testing a high-tension alternator for efficiency it is quite sufficient to load up the machine on water resistance to measure the current going out of the machine as ordinarily measured on an alternating-current ammeter, to measure the difference of potential at the terminals of the machine as measured on an alternating-current voltmeter, and to multiply the values of the two readings together, and thus obtain the true power in watts being given out by the machine on the water load. There is no question of difference of phase in this case. If, however, the alternator is working upon an inductive load, such as a number of transformers lightly loaded, then the current curve lags behind the E.M.F. curve by a definite amount at the zero value. This is shown in curves (Figs. 11, 12, and 13) giving respectively the E.M.F. and current curves of a Mordey alternator, and a Thomson-Houston alternator working on transformers lightly

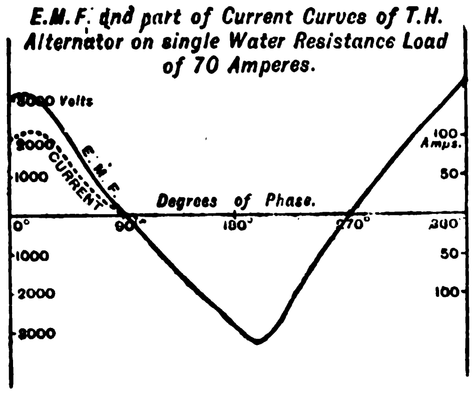

FIG. 15.

loaded. It will be seen that the difference of phase between the current and E.M.F. curves is different at different parts of the curve; in the case of the Thomson-Houston alternator there is no difference of phase between the maximum values of the current and E.M.F., but a considerable difference between the zero values. In the diagram of the Thomson-Houston alternator the position of the field poles is shown by the square rectangles, which, therefore, indicate the manner in which the E.M.F. curve is related to the field poles in the machines. It must not be supposed that the form of the current curve or of the E.M.F. curve is a fixed attribute of the alternator—that is to say, we cannot speak of the E.M.F. curve of an alternator as if it were something unchangeable and peculiar to that machine. It often largely depends upon the nature of the load. Thus, for instance, in Fig. 14 is shown the form of the E.M.F. curve of a Thomson-Houston alternator when very lightly loaded, and in Fig. 15 is shown the E.M.F. curve of the same machine when loaded on a non-inductive resistance to a fair proportion of its full load; whilst on referring to Fig. 13 we see the form of the E.M.F. curve of the same machine when working on an inductive load, and it will be noticed how very different in form are those three curves. Generally speaking, in a machine like the Mordey alternator with a very small armature reaction, there is very little change in the form of the E.M.F. curve with the nature and amount of the load on the alternator, but in the case of a machine like the Thomson-Houston or Westinghouse alternator with a large armature reaction there is a very considerable change in the form of the E.M.F. curve which changes in the amount and nature of the load. In the above cases the form of the E.M.F. curves have been set out graphically in what are called wave diagrams, in which the horizontal ordinates represent time, and the vertical ordinates represent the magnitude of the quantity which is varying, whether E.M.F. or current. For some purposes this method is not so con-

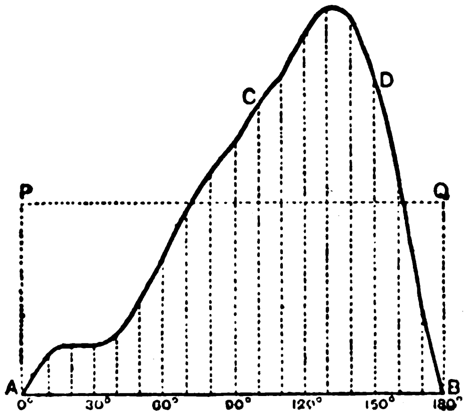

FIG. 16.

venient as that of setting out the curves in the form of polar diagrams.

The differences between these two methods — graphically delineated a periodic quantity—are shown in Figs. 16 and 17. In Fig. 16, part of the curve of the E.M.F. of a Thomson-Houston alternator on an inductive load is shown. In Fig. 17 the same quantity is delineated in a polar curve. Instead of drawing vertical ordinates at equal distances to represent the instantaneous values of E.M.F., radii are drawn from a point, O, at equal angular intervals, the magnitudes of which are respectively proportional to the instantaneous values of the periodic quantity. A curve, B C D, is thus obtained which is called a polar curve. It has this interesting property, that if we find the area of the polar curve, and describe a semicircle on a line, P Q, passing through the pole, O, the area of which is equal to the area included by the polar curve, B C D, it can easily be shown that the radius of this semicircle represents the square root of the mean of the squares of all the radii of the polar curve. This quantity is now generally called the R.M.S. value, or the root-

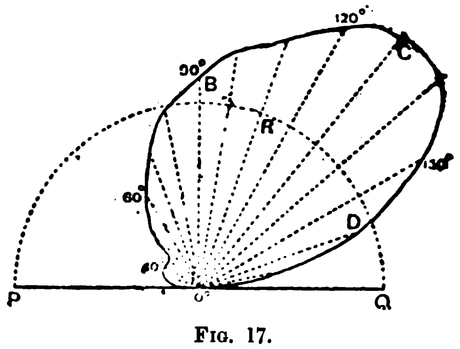

FIG. 17.

mean-square value of the periodic quantity. By some writers it has been called the effective or virtual value. Ordinary alternating-current ammeters and voltmeters give, as is well known, the R.M.S. value of the periodic quantity they are measuring.

Returning to Fig. 16, if we construct a rectangle, A P Q B, equal in area to the area included by the wave curve, A C D B, then it is easily seen that the height of this rectangle—namely, A P—represents the true mean value of the periodic quantity represented by the ordinates of the wave curve. In the case of any periodic quantity, such as a periodic E.M.F. or current graphically delineated, it is found convenient to have a term to denote the ratio between the true mean value of the curve ordinate and the root-mean-square value, and this is called the form-factor of the curve.*

(*To be continued.*)

* For further information on this point see "The Alternate-Current Transformer," Fleming, vol. i. (new edition), p. 583.

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LEGAL INTELLIGENCE.

THE HOPKINSON PATENT.

The petition by Dr. John Hopkinson, F.R.S., and the Westinghouse Electric Company, Limited, for the prolongation of letters patent granted to Dr. John Hopkinson in 1882 for a term of 14 years, for an invention of "improvements in distributing and measuring electricity and in apparatus to be employed for those purposes," was heard on Wednesday by the Judicial Committee of the Privy Council. The Court was constituted as follows: Lord Hobhouse, Lord Macnaghten, Lord Davey, and Sir Richard Couch.

The petition being one of great importance to the electrical industry, the hall of the Judicial Committee of the Privy Council was unusually crowded by counsel, specialists, and representatives of various municipal corporations. Amongst the opponents of the prolongation being Messrs. Crompton and Co., Limited; Callender's Bitumen Telegraph and Waterproof Company, Limited; the municipal corporations of Liverpool, Nottingham, Glasgow. Edinburgh, Dundee, Aberdeen, Blackburn, Oldham. Harrogate, Burnley, Dewsbury, Lancaster, Brighton, Belfast, Sunderland, Bradford, and Hull, and the National Electric Supply Company. Among the specialists in attendance were Lord Kelvin, Sir F. Bramwell, Prof. Boyes, Dr. Hopkinson, and Prof. Kennedy, the latter being the only specialist whom it was intended to call on behalf of the objectors

Mr. Moulton, Q.C., Mr. Roger Wallace, Q.C., and Mr. A. J. Walter appeared for the petitioners; Mr. Cripps. Q C., Mr. J. C. Graham, Mr. Bousfield, Q.C, and Mr. C. E. E. Jenkins, Mr. Terrell, Q.C., and Mr. C. Fleetwood Pritchard, Mr. J. C. Graham, Mr. W. Neill, Mr. A. J. Ashton, and Mr. C. E. E Jenkins (for the Birmingham Electric Supply Company, Limited), appeared for various objectors; and the Attorney-General, Mr. Henry Sutton, and Mr. Dennis appeared for the Crown.

The petitioners' case, in brief, was that prior to the invention patented by Dr. Hopkinson there were numerous difficulties in the way of the distribution of the electric current to incandescent lamps which the inventor claimed to have removed, and at the same time to have effected an enormous saving in the cost of the copper necessary for the construction of the main conductors, such saving amounting, in the case of the licensees of the patent, to a total of over £220,000. The invention introduced what is known as the "three-wire system." From want of capital Dr. Hopkinson found so much difficulty in getting his invention before the public, and in protecting his legal rights, that he was compelled to assign his rights, except in the legal estate, to the Westinghouse Company (the joint petitioners), who had worked it since 1889, and granted numerous licenses. The company, on their part, claimed that they had done a public service by coming to the assistance of the inventor, and making his invention of great public utility, but, as they had sustained a loss, they alleged, up to the present time, through the heavy legal and other expenses incurred of over £7,000, they prayed for the prolongation of the patent for another 14 years.

Before the Court heard Mr. Moulton in support of the above case, the **Attorney-General** took a preliminary objection. On the face of the petition Dr. Hopkinson had sold his interests in the English and German patents to the Westinghouse Electric Company for a sum of £19,750. While admitting the merit of the invention he submitted that Dr. Hopkinson had been adequately remunerated in respect of it by the amount which he had received from the company, and that as the inventor had thus been adequately remunerated for his invention the company were not entitled to claim a prolongation of the letters patent. The Attorney-General then quoted the judgment delivered by Lord Watson in the Bower-Barff patent case.

Mr. Moulton, Q C., for the petitioners, submitted in reply that the patent was one of very great merit, and the remuneration had been inadequate. Immediately after taking out the patent the petitioner used every endeavour to procure the adoption of his invention, but electric lighting was in its infancy and central lighting installations were so hampered by legislative provisions that for the first six years of the patent there was practically no opportunity for its application. A patentee who sold his rights in a patent did not thereby destroy the claim of the person who acquired the patent to the favourable recognition of their Lordships

The **Attorney-General** replied, and

Lord Hobhouse said their Lordships were of opinion that the objection raised by the Attorney-General arising on the face of the petition must prevail, and, therefore, their Lordships could not report to her Majesty in the way which was necessary for a prolongation of the patent. Their Lordships would give their reasons on some future date. They would allow one set of costs.

COMPANIES' MEETINGS AND REPORTS.

BRITISH ALUMINIUM COMPANY, LIMITED.

Directors: R. W. Wallace, Q.C., 21, De Vere-gardens, Kensington, W., chairman; A. S. Bolton, J.P., Moor Court, Oakamoor, N. Staffordshire; A. A. Common, LL D., F.R.S., 63, Eaton-rise Ealing, W.; Harvey du Cros., 14, Regent-street, London, S.W.; Robert Heath, J.P., Greenway Bank, Stoke-on-Trent, Staffordshire; E. Ristori, A.M.I.C.E, 2, Halkin-street, Grosvenor-place, S.W. Secretary: Charles F. Jones.

Directors' Report: In presenting their first annual report to the shareholders, the directors express their satisfaction in being able to state that the several factories of the Company are so far completed that the production of aluminium by the cheapest known processes and from entirely British raw material is now in successful operation. The acquisition of the necessary elements for the cheap production of this metal has been effected on favourable terms. Since the formation of the Company the following works have been carried out: (*a*) Bauxite mines at Glenravel (co Antrim) have been opened out and arrangements made that will assure an unlimited supply. (*b*) A large chemical factory has been built at Larne (the nearest harbour to the mines) and equipped with apparatus and machinery equal to the production of several thousand tons of alumina per annum under Dr. Bayer's process, the patents for which are owned by the Company. This factory is now in successful operation, and the alumina made is used at the Foyers factory. (*c*) The patent rights acquired by the Company to protect the production of aluminium, also cover the production of carbide of calcium, and the Company has granted to the Acetylene Illuminating Company, Limited, a license to manufacture this product. The directors expect that at an early date considerable profit will be derived from this source. (*d*) The freehold estate of Foyers, on Loch Ness, containing suitable water power, has been bought, together with the water rights of adjacent properties. The necessary engineering works have been carried out, comprising a long tunnel through the rock, lines of pipes, buildings, turbines, dynamos, furnaces, etc., and the factory is now in operation. (*e*) The Milton Factory acquired from the Cowles Syndicate Company, Limited, has been greatly improved and enlarged, by the erection of new buildings, a complete new rolling plant, other machinery, and additional furnaces. This factory had been in full and profitable work for some months. The directors, having found that aluminium manufactured according to certain of the Company's patents, has been imported into this country, are taking steps to stop further importation of the metal The directors have now resolved to issue the balance of the preference shares in order to provide for an increased output of metal. According to the articles of association, two of the directors, Messrs. A. S Bolton and A. A. Common, retire by rotation, and, being eligible, offer themselves for re-election. The auditors, Messrs. Crewdson, Youatt, and Howard, also retire, but offer themselves for re-election.

The first general meeting of the above Company was held on Thursday last at the Westminster Palace Hotel. The chair was taken at 12 30 by Mr. R. W. Wallace, Q.C.

After the minutes of the last meeting had been read, the **Chairman** explained to those present the position and objects of the Company. He said that he wished to draw attention to the fact that there was no connection between "the British Aluminium Company" and the "Aluminium Company." The latter undertaking did not produce aluminium, but only manufactured the aluminium when produced by others. There were three other places in which aluminium was now being manufactured—*i.e.*, at Neuhausen, on the Rhine, at Niagara, and at Froges, in France. With the company whose works were at Neuhausen the British Aluminium Company were on most friendly terms, and they had entered into a mutual agreement by which the German company would not import their productions into the United Kingdom. He could not say, however, that the relations with the American company were so satisfactory, as it had not yet acknowledged the patent rights of his Company. As the Niagara people were importing aluminium into England a legal action was pending. The chairman afterwards explained the English Government had acknowledged their patent rights and were paying royalty accordingly. After referring to the great reduction in the price of aluminium during the past 10 years, Mr. Wallace explained that the Company decided in the early days of its existence that the Neuhausen process was the best. The directors accordingly decided to take up a strong position, and to secure as much of a monopoly as possible. They accordingly acquired the whole of the patent rights of the process, a full control of the raw material they required, and ample water rights. They also entered into successful negotiations with the Cowles Company at Stafford, by which their interests were merged into the British Aluminium Company. The directors then acquired the mining rights over certain bauxite deposits in County Antrim, Ireland, at the low royalty of 6d. per ton. That was equivalent to paying only 2s 6d. for the raw material required to manufacture one ton of aluminium. The five tons of bauxite so required were reduced by a chemical process to two tons of pure alumina at the Company's works at Larne, and then exported to Foyers on Loch Ness. At this place they had purchased an estate of 8,000 acres and water rights over 100 square miles. That enabled them to set to work without an Act of Parliament, and the estate was acquired on such advantageous terms that the cost of the water power was practically nothing. The aluminium produced at the works was taken to Milton, in North Staffordshire, where it was manufactured into whatever commercial form may be desired. Mr. Wallace then referred at some length to the details of the Foyers works, which were described fully in our issues of April 24 and May 8, 1896. He then moved the adoption of the report.

Lord Kelvin seconded the adoption of the report, and congratulated the shareholders that their first report should be such a good one. He had personally inspected the works last September, and then did not believe it possible the aluminium could be produced at Foyers at such an early date as July this year. Such rapid progress reflected great credit on all concerned. He was pleased to note the way the Scotch people had welcomed this new industry, and thought that

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the value of the water power now running to waste in the Highlands was more likely to be utilised. He considered that the Foyers plant was practically the first water-power plant in Great Britain, and he hoped that in Scotland especially it would give rise to a number of transmission of power schemes which would enrich the land.

The motion for the adoption of the report was then put and carried *nem. con.* The retiring directors were then re-elected, as were also the auditors of the Company.

After a vote of thanks the shareholders present adjourned to an adjoining room, where a number of samples of aluminium goods were on view. The domestic utensils, such as stew pans, kettles, etc., were strongly in evidence, as the sanitary nature of aluminium vessels would warrant. The British Aluminium Company will not, however, undertake the manufacture of such ware, but will confine themselves to the supply of sheet and wire aluminium, or of the metal in ingots and castings.

UNITED RIVER PLATE TELEPHONE COMPANY, LIMITED.

The tenth annual general meeting of this Company was held on Tuesday at Winchester House, E.C., Mr. J. Irving Courtenay presiding.

The **Chairman**, in moving the adoption of the report, a summary of which was given in our last issue, congratulated the shareholders on the improved condition of their property. The results of the past year's working, to March 31, were better and their prospects looked brighter, and the directors therefore recommended a dividend of 4 per cent. on the paid-up share capital, being an increase of 1 per cent. upon the distribution of the previous year. Matters changed rapidly in the Argentine Republic, and periods full of promise had been suddenly succeeded by gloom and anxious times. It was therefore all the more gratifying to observe the increasing steadiness and stability of affairs generally on the River Plate, by which the Company had profited to an extent which had quite equalled their expectations. The system of accounts had been altered, the receipts and expenses having been taken at the actual sterling value each month instead of at the par of exchange, as heretofore. The gross receipts had been £48,744, as against £36,673 in the previous year; and the working expenses in the Argentine had been £24,967, as against £17,555. To give a first-class service such as the Company now afforded it was necessary not only to have the plant in good working order, but that it should be handled by intelligent and skilful operators, who naturally commanded good wages. Their subscribers continued to augment, there being a total on March 31 of 6,231, or an increase of 433 for the year. Exchange had also been more favourable to them. Their plant generally was in very good order, but a large continuous outlay was necessary owing to the opening of new streets and the erection of new buildings. Mr. Chappell, their general manager in the River Plate, reported that most of the important alterations and repairs to their outside lines and wayleaves, which were commenced over a year ago, were either finished or rapidly approaching completion and they would be of immense benefit to their service. The Provincial Telephone Company, in which they were largely interested, was steadily progressing and had had an increase of subscribers of something over 10 per cent.

Mr. F. Jones, managing director, seconded the motion, which was agreed to.

THE ALUMINIUM COMPANY, LIMITED.

The report of the directors of this Company for the year ending June 30 states that the general business of the Company at Oldbury and the various undertakings in which the Company are interested are progressing satisfactorily. The accounts show a profit of £50,681 for the financial year. After providing for debenture interest amounting to £6,738 and other fixed charges, there remains a balance of £38,003, which, with the sum of £2,076 brought forward from last year, leaves the net profit at £40,080. The directors recommend the payment of a dividend of £15 per cent. on the "A" shares, which will absorb £9,000; that £10,000 shall be written off the works and £10,000 off the patents, leaving the sum of £11,080 to be carried forward. Ten thousand pounds has already been deducted from the amount at which the patents stood in the books of the Company. This represents the value of a portion of a patent which was included in the assets of the Company in the last balance-sheet, and has since been sold. Thirty-three thousand five hundred and twenty-three pounds out of the net profits for the year arises from the cash profit made on the sale of patents, etc., which were included among the assets of the Company at a nominal figure. During the year the £10 per cent. "B" debentures, amounting to £12,000, have been paid off, and it is intended to pay off the issue of £100,000 6 per cent. debentures on October 1, and issue in their place £90,000 4½ per cent. first mortgage debenture stock. The debenture debt will then be reduced by £21,800, saving an annual interest payment of £3,363. The contract with the Castner-Kellner Alkali Company, referred to in the last report, was duly completed, and the shares in that company held by this Company have been placed to reserve, and will, it is expected, in the near future add very materially to the Company's annual profits. The provisional contract of sale with the Mathieson Alkali Company has been confirmed, and all instalments due to the present time have been paid. The shares received in part payment have been treated in a similar manner to those held in the Castner-Kellner Alkali Company. Large works are about being erected by the Mathieson Alkali Company at Niagara Falls, and after January 1 the profits of this Company will further be increased by a royalty fixed at a minimum of £4,000 per annum. The American company, which was mentioned in the last report, was duly incorporated under the title of the Niagara Electro-Chemical Company, and are also erecting works at the Niagara Falls. It is expected these works will be completed in the course of the ensuing month. Negotiations for the sale of the British and Continental rights under similar patents to those sold to the Niagara Electro-Chemical Company are now proceeding.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Altona.—Tenders will be received up to July 21 by the Prussian State Railway Administration at their Altona office for the supply of about 21 tons of telegraph wire.

Mile End (London).—Tenders are invited by the Guardians for the electric lighting plant for their premises in Bancroft-road. The date is July 30, and particulars will be found in our advertising columns.

Bucharest.—Tenders will be received up to August 8 by the Roumanian Government (Department of Posts and Telegraphs) for the electric lighting of the new Posts and Telegraph building at Bucharest.

Vich (Spain).—The contract will be allotted by the municipal authorities of Vich on August 17 for the electric lighting of the town for 10 years from June, 1897. The annual payment proposed is about £800.

Amsterdam.—Tenders will be received up to 21st inst. by the Engineering Department, Plantage Lijnbaansgracht, Amsterdam, for work in connection with the establishment of telegraphic and telephonic lines. The amount is slightly under £2,000.

Hull.—The Corporation require tenders for the supply of an engine and dynamo to run 40 16-c.p. lamps for the lighting of the East District sewage pumping station. Further particulars may be obtained of Mr. A. E. White, borough engineer, Town Hall, Hull. Tenders, endorsed "Engine and Dynamo," are to be delivered to the borough engineer by 23rd inst.

Mexico.—Sealed tenders will be received by the secretary of the City Council of the city of Mexico, not later than the last day of August of the current year, for the lighting of the city by electricity. All information and conditions of tender, plan of the city of Mexico, etc., can be obtained on application at the Mexican Consulate, Broad-street House, New Broad-street, London.

Simla (India).—The Municipality is inviting tenders for lighting by electric light for a term of years the principal thoroughfares and buildings belonging to the Municipality. Tenders must be submitted by September 1 next. Should any proposal be accepted, the Municipality will afford the successful tenderer all facilities to extend the system of lighting to private houses.

Cologne.—Tenders are required by the Municipal Authorities for the construction and working of electric tramways in the city of Cologne to an aggregate length of 20·3 kilometres (12½ miles). Specifications, plans, and particulars are obtainable for 10 marks (10s.) from der Registrateur B, des Oberbürgermeisteramt, Köln, Germany, and tenders must be in by November 6.

Madras.—Tenders are invited for the lighting by electricity of Government House, Madras, including the banqueting-hall and aide-de-camps' bungalow, and also for the lighting of Government House, Guindy, including the military secretary's bungalow. For particulars application must be made to the consulting architect to the Government, Chepank, Madras. Tenders will be opened on November 11, 1896.

Lisbon.—The Royal Portuguese Railway Company want tender by July 22 for the supply of 10,000 porcelain insulators with galvanised iron supports, 200 sheets of asbestos (1 metre square by 2 millimetres thick), and about 2½ tons of galvanised iron wire. The tenders are to be addressed to the Chief of the Stores Department at Santa Apolonia Station, Lisbon and particulars can also be obtained at Paris, Rue de Châteaudun 28.

Blackpool.—The Corporation require tenders for the supply of coal and oil to the electricity department. Specifications may be obtained on application to Mr. Robt. C. Quin, borough electrical engineer, Corporation Electricity Works, West Caroline street, Blackpool, and sealed tenders must be delivered at the electricity works not later than 10 a.m. on 27th inst., addressed to the Chairman of the Electric Lighting Committee, and endorsed "Tender for Coal" and "Tender for Oils" respectively.

Bristol.—The Electrical Committee invite tenders for the supply of (*a*) pea nut coal washed, (*b*) pea nut coal, unwashed, to the electric lighting station, Temple-back, Bristol, for six or 12 months (at their option) from August 1. A copy of the specification and forms of tender can be obtained from Mr. Frank Wm. Prosser, secretary, Temple-back, Bristol. Tenders must be delivered by noon on 24th inst., addressed the Secretary, Electricity Department, Temple-back, Bristol, and endorsed "Tender for Coal."

Mexico.—The municipal authorities of the city of Mexico are prepared to receive proposals for the street lighting by incandescent

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lamps for a period of eight years. Tenders should be sent in by August 31. The Secretary of State for Foreign Affairs has received from the British Consul at Mexico a pamphlet issued by the Municipal Council of the city containing particulars as to the tenders, and this may be seen on application to the Commercial Department of the Foreign Office between the hours of 11 and 6.

Voghera (Italy).—In view of the expiration of their contract with the local gas company in 1898, the municipal authorities of Voghera are desirous of receiving during the present year propositions for the lighting of the town either by the electric light or a mixed system of gas and electricity. The population is 16,000. Application should be made to L'Administrazione Comunale, Voghera, who will give all particulars necessary.

San Juan (Puerto Rico).—H.M. Secretary of State for Foreign Affairs has received from H.M. ambassador at Madrid a copy of a Spanish Royal Order which has appeared in the *Gazette* inviting tenders for the construction and working of a telephone system in San Juan de Puerto Rico. A deposit of 800dol. must accompany each tender, which will be considered on August 10. The copy of the Royal Order may be seen on application to the Commercial Department of the Foreign Office between the hours of 11 and 6.

Bray (Ireland)—The Township Commissioners invite tenders for (*a*) erection of a brick chimney, 100ft. high, (*b*) sundry alterations to existing buildings at the electric light and power station. Plans and specifications may be inspected at the Town Hall, Bray, between 10 a.m. and 4 p.m. Separate tenders to be given for Section A and B. Tenders, properly sealed, and endorsed 'Tender for Chimney" or "Tender for Alterations," as case may be, to reach Mr. P. MacDonnell, town clerk, before 10 a.m. on 20th inst.

Hull.—Tenders are required by the Electric Lighting Committee for the supply of best South Yorkshire hard steam doubled-screened nuts for 12 months ending June 31, 1897, in accordance with the conditions set forth in the form of tender, which may be obtained at the Electric Lighting Offices, Dagger-lane. The contractor will have to enter into the usual form of contract required by the Corporation. Tenders, endorsed "Double-Screened Nuts for Electric Lighting Station," to be sent, under seal, to the chairman of the Electric Lighting Committee, Town Hall, by noon on 30th inst. Mr. A. S. Barnard, borough electrical engineer, Electric Lighting Station, Dagger-lane.

Army Contracts.—The Secretary of State for War gives notice that tenders for specific quantities of the following articles will probably be invited from time to time during the next twelve months — namely: submarine mining electrical instruments, telegraph cable and wire, etc. Manufacturers who may wish to be applied to when tenders are required should address the Director of Army Contracts, War Office, Pall-mall, S.W., by letter, stating the particular articles which they manufacture, and the names of at least two well-known firms or public bodies who have purchased from them, and are in a position to certify as to the quality of their productions. Applications unaccompanied by references will not be noticed. Firms whose names are already on the War Office list need not apply, as forms for tendering will be sent to them in due course.

Egremont (Cheshire).—Tenders are invited by the Wallasey Urban District Council for the erection of an additional six-celled Fryer's patent refuse destructor, with Boulnois and Brodie's patent charging apparatus, Jones's fume cremator, steam-engine, and mortar mills, together with additional roofing buildings and electric lighting in connection with the existing refuse destructor works at Gorsey-lane, Poulton. Plans may be seen and specifications and forms of tender obtained on payment of £2. 2s., which will be returned on receipt of a bona fide tender, at the offices of the engineer and surveyor, Mr. Arthur Salmon, A.M.I.C.E. Separate sealed tenders, addressed to the chairman of the Health Committee, and endorsed "Destructor Contract D, E, F, or G," as the case may be, to be left at the office of Mr. W. Danger, clerk, Public Offices, Egremont, by 5 p.m. on 20th inst. The contractor will be required to enter into a bond, with approved sureties, for the performance of contract, which contract and bond will be prepared at the expense of the contractor.

Kingston (Jamaica).—The Colonial Government invite electric tramway contractors willing to undertake the establishment and working of a system of rapid transit to send in applications for the grant of a license by the Governor in Privy Council under the Tramways Law, 1895. In all applications the principal questions to which attention should be directed are the following: (*a*) the amount of capital which the applicants are prepared to subscribe; (*b*) the system which it is proposed to establish; (*c*) the mileage of lines to be laid; (*d*) the fares to be charged; (*e*) the frequency of the service; (*f*) the length of the license required by applicants; (*g*) the guarantee which the applicants offer for the satisfactory performance on their part of any obligations devolving on them. Plans of the city of Kingston and part of the parish of St. Andrew, showing the routes on which the present tramway lines are laid, and copies of the law under which licenses are granted and of the rules made thereunder by the Governor in Privy Council, may be seen at the office of the Crown Agents for the Colonies, Downing-street, London, S.W. All applications must be delivered not later than July 31, 1896, in a sealed packet, marked on the outside "Application for Tramway License," to the clerk of the Privy Council, Kingston, Jamaica. Kingston has its principal means of transit at present supplied by the Jamaica Street Car Company by horse tramcars, the entire length of lines laid being about 12 miles. The concession granted by the Legislature of the island to the Jamaica Street Car Company will shortly expire.

RESULTS OF TENDERS.

Ealing.—The District Council have accepted Messrs. W. Foord and Son's tender (£1,952) for extensions to the electric lighting station.

Wakefield.—The estimate of the Private Wire and Telephone Installation Company for providing and fitting telephones throughout the new municipal buildings has been accepted.

Puebla de Rugat (Spain)—A contract for electric lighting in this little town, which is in the province of Valencia, has been allotted to Messrs. Serra and Ramirez at 1,200 pesetas (£48) per annum for 10 years.

Plymouth.—The Town Council have accepted the tender of the British Insulated Wire Company for the supply of the underground electric cables required for Old Town, Ebrington, and Ham streets for £723, subject to the approval of the Local Government Board.

BUSINESS NOTES.

Western and Brazilian Telegraph Company.—For the past week the receipts were £2,889.

Mile End.—The Vestry have rejected a proposal to apply for an order to light the parish by electricity.

Bournemouth.—The pier will most probably be illuminated and decorated by the electric light shortly.

Stockton.—The Board of Trade have agreed to extend the borough electric lighting order for another two years.

Dewsbury.—The electrical energy generated during three weeks ended June 20 was 2,605 units, against 1,044 units last year.

Hove.—The electric lighting company have applied to the Urban District Council for permission to increase the pressure of electricity.

Aston.—The District Council have adopted the specifications submitted by Mr. Vawdry for the extension of the electric lighting plant at the baths.

Lowestoft.—The General Purposes Committee have been instructed to take into consideration the advisability of the Town Council introducing the electric light.

Notting Hill Electric Lighting Company.—The Company have declared an interim dividend for the six months ending June 30 at the rate of 6 per cent. per annum, payable forthwith.

Bermondsey.—The Vestry have decided to oppose the application of the London and Brush Provincial Electric Lighting Company, Limited, for a provisional order for lighting the district.

Address.—We learn that Mr. A H. Vesey has relinquished his private practice as a consulting engineer, and has joined the firm of Messrs. Vaughan and Brown, Kirby-street, E.C., in a similar capacity.

Telegraph Construction and Maintenance Company.—The directors announce the forthcoming payment of an ad interim dividend of 12s. per share to all shareholders on the register on 13th inst.

Darfield.—The Urban District Council have resolved to invite Mr. Johnson (Tasker, Sons, and Co., of Sheffield) to make a tour of the township and give an estimate for the lighting of the streets with electricity.

Barrow.—The Corporation having had a report from Mr. E. Manville on electric lighting, with a map showing the positions of the proposed mains, have ordered a hundred copies of the report to be printed and distributed.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending July 12 amounted to £1,252, as compared with £1,186 in the corresponding week of the previous year, being an increase of £66.

Accumulators.—We have to acknowledge the receipt from the Elektricitäts-Gesellschaft Gelnhausen of their catalogue and price-list, dated June, 1896, of storage battery cells. The address of the company is Gelnhausen, Germany.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ending July 10 were £2,419. 5s. 7d., compared with £2,064. 8s. 5d. for the corresponding period of last year, being an increase of £354. 17s. 2d.

The Fastnet Lighthouse.—In reply to Sir J. Leng (Dundee), in the House of Commons last week, Mr. Ritchie (Croydon) said the amount already spent in connecting the lighthouse is about £2,600. The estimate for further expenditure is £850.

City of London Electric Lighting Company, Limited—Warrants for the payment of an interim dividend for the half-year ended June 30, 1896, at the rate of 6 per cent. per annum on this Company's preference shares were posted on Wednesday.

County of London and Brush Provincial Electric Lighting Company.—The directors have declared an interim dividend for the half-year on the first and second issues of preference shares at the rate of 6 per cent. per annum, payable on the 21st inst.

Blackburn.—The electricity supply fund shows that the total expenditure to December 31, 1895, was £25,783. 17s 3d., and the amount raised by loan was £22,000. The revenue account shows an income of £1,216. 1s. 9d., and an expenditure of £1,205. 1s.

Electrical Books.—A useful little book is the classified catalogue of electrical books which is issued by the W. J. Johnston Company, 253, Broadway, New York. It contains a description of every electrical book on the market, and its price in American coinage.

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Halstead.—At the meeting of the Urban District Council the Lighting Committee reported that they had placed the report in the hands of a sub committee, who would ascertain how many people would be inclined to have private lights. The report was adopted.

Camberwell —The General Purposes Committee reported at the meeting of the Vestry that the National Telephone Company had commenced laying the cable underground in the Old Kent-road, in accordance with the permission granted by the Vestry in March last.

Gateshead —A number of members of the Corporation, accompanied by members of the Parliamentary Committee of that body, have visited Sunderland in order to look over the electric works in that borough, with a view to considering the desirability of having electric lighting in Gateshead.

City and South London Railway.—The returns for the week ended July 12 were £937, compared with £848 for the corresponding period of last year, being a decrease of £89. The total receipts for the half-year 1896 were £1,818, compared with £1,763 last year, being an increase of £55.

Brandon.—At the meeting of the Urban District Council the Chairman stated that he had seen Mr. Greener that morning in regard to the lighting of the west ward, and he told him that he had not yet received any tenders from the electric lighting company, but expected them every day.

Leatherhead.—The clerk stated at the meeting of the Urban District Council that he had received a letter intimating that a provisional order was to be applied for on or before December 21 empowering a company to supply Leatherhead with the electric light. The letter was allowed to lie on the table.

Direct United States Cable Company.—The Board have resolved to recommend a final dividend of 2s. 6d. per share, free of income tax, making, with the interim dividends already paid, 2¼ per cent. for the year ending June 30, and, after placing £7,500 to reserve fund account, carrying forward a balance of £4,235.

Burrelton.—The villages of Burrelton and Woodside being now formed into a special lighting district, there is some talk of discarding the oil lamps now in use and going in for electricity. There is a disused water power at the south end of the village which could be utilised for the producing power at small cost.

Newport (Mon.).—The electric light is progressing rapidly, and the cables are being extended in all directions. The provision of a sub-station in the basement of the town hall, on the Austin Friars side, at a cost of £900, is under consideration, and the new landing-stage for excursion traffic is to be provided with the light.

Watford.—The committee appointed to consider the question of appointing an electrical engineer reported that they had fully considered the applications received, and recommended the Urban District Council to appoint Mr. W. C. C. Hawtayne to fill the post. At the meeting of the Council the recommendation was agreed to.

Dissolution of Partnership.—The partnership existing between Mr. Bennett and Mr. Wm. H. Druce, under the style of "Bennett and Druce" was dissolved on June 26. Mr. Druce has taken offices at Temple-chambers, 33, Brazennose-street, Manchester, and will in future devote himself exclusively to the practice of consulting engineering.

Dublin.—A presentation of an illuminated address from the employés of the Dublin Electric Tramway Company, and several pieces of plate, was made last week to Mr. T. B. Halliday, superintendent of the line, on behalf of Mr. J. Clifton Robinson, on the occasion of his retirement from the managing directorship of the company.

Shoreditch.—At the meeting of the Vestry, Mr. Kershaw drew attention to the question of laying the electric mains, which, he said, was making very slow progress. At the present rate the work would take 32 weeks to complete, and under the circumstances the Vestry decided to sanction the employment of another gang of workmen to be set on Haggerston.

Anglo-American Telegraph Company.—The directors have resolved, after placing £6,000 to the credit of the renewal fund, to declare an interim dividend for the quarter ending June 30 of 12s per cent. on the ordinary stock, and 24s. per cent. on the preferred stock, less income tax, payable on August 1 to stockholders registered on the books of the Company on July 8.

Kingswood.—At the meeting of the District Council a letter was read from the electric light contractors *re* the purchase of their installation by the Council, wherein it was stated that they were willing to allow the offer to purchase to remain open a little longer. In conclusion, the letter stated that the question should be considered at the earliest opportunity, as it could not be delayed indefinitely.

Aluminium Company Debentures.—Messrs. Robarts, Lubbock, and Co. are instructed to receive applications for an issue by the Aluminium Company, Limited, of £90,000 4½ per cent. first mortgage debenture stock, at the price of £103 per cent., redeemable, at the option of the Company, on or at any time after October 1, 1906, at £110 per cent. at six months' notice. The list will close on or before Saturday, at 11 a.m.

Ealing.—The Electric Lighting Committee reported at the Urban District Council meeting that Mr. G. Thompson had applied to have the electric light supplied at his house at Waldeck-road. On the recommendation of the committee, the Council instructed the clerk to inform Mr. Thompson that his was the first application from Waldeck-road, and an extension of the mains could not be entertained until there were other applications.

Aberdeen.—The employés of the electric lighting station, Cotton-street, held their annual outing last week. The party, to the number of 14, went to Crieff, and during the early part of the day Drummond Castle was visited. In the afternoon the party sat down to dinner in the Commercial Hotel, Crieff, under the presidency of Councillor Johnston, convener of the Gas and Electric Lighting Committee. Perth was subsequently visited.

Battersea.—At the meeting of the Vestry no order was recommended by the Dusting Committee on a request from the Battersea Tradesmen's Club that Battersea Park-road between Latchmere-road and Victoria-road might be lighted by electricity. With reference to electric lighting, the County of London and Brush Company wrote informing the Vestry that they would not proceed with their application for a provisional order so far as the application related to Battersea.

Morecambe.—At the District Council meeting, a draft agreement for the purchase from the rector of land required for electric light work was approved, Mr. Thos. Parker, electrical engineer, Wolverhampton, being instructed to prepare the plans, estimates, and reports required by the Local Government Board and Board of Trade for enabling the Council to take over the undertaking of the Morecambe Electric Light and Power Company and establish a new electric light station.

Birmingham. — The following resolution was passed at a meeting of telegraph clerks: "That this meeting of the Birmingham Postal Telegraph Clerks' Association expresses its keen dissatisfaction with the evidence given and the proposed scale of pay submitted by Mr Lewin Hill to the Inter-Departmental Committee on Post Office Establishments, and respectfully urges that, far from removing grievances and allaying discontent, they will only aggravate and enhance them."

Levenshulme.—At the meeting of the Urban District Council the clerk read a letter from the South Manchester Electric Supply Company, Limited, stating that they were about to make an application to the Board of Trade for the grant of a provisional order for the supplying of electricity in Levenshulme. A letter informing the Council of a similar intention on the part of the Altrincham Electric Supply, Limited, was also read. The letters were referred to the General Purposes Committee for consideration.

City and South London Railway Company.—The accounts of the Company for the half-year ended June 30 show a balance, after providing for the debenture interest and the full dividend on the 5 per cent. preference shares, sufficient to allow the payment of a dividend on the consolidated ordinary stock at the rate of 1⅝ per cent. per annum, carrying forward a balance of £1,072 to the new account. The dividend for the corresponding period last year was at the rate of 1⅛ per cent per annum, the balance carried forward being £965.

Islington.—The Vestry having, like St. Pancras Vestry, retained the supply of electricity in the parish over which it exercises control in its own hands, has already expended or incurred liabilities amounting to £96,383. The demand for the electric light by private consumers has greatly increased, and is augmenting. Hence the Electricity Committee find it necessary to ask the Vestry to sanction an additional expenditure of £20,000. This it is proposed to raise by loan to meet the requirements of the undertaking.

Edinburgh.—At the meeting of the Town Council the Cleansing and Lighting Committee's report showed a deficit of £721, entirely due to the electric light, and of £3,287 on cleaning, but it was right to explain that in the expenditure was a sum of £4 800 as expenses in connection with the destructor case in the Court of Session, otherwise the committee would have had a surplus of £1,500 in the cleaning account. The total surpluses in favour of the committee were £5,959 and the net deficiencies £5,629—a net surplus of £330.

The London Tramways Question.—Next week a report of the Highways Committee of the London County Council will be presented on this subject. The committee adhere to their recommendation, that the Council should lease the lines to the two companies until 1910. They will report against the Council working the lines or using electric traction, and will adduce additional facts and figures in support of their recommendation and against the instructions from the Council carried at the instance of Mr. Baker.

Witton Gilbert.—At the meeting of the Parish Council the agreement with the Bearpark Coal Company, in reference to the poles at Dene Burn Cottages having been duly executed, was approved of. The Corlett Electrical Engineering Company's account was produced, showing a balance of £86. 3s. 2d. still due to them on contract and additions thereto, and, on the motions of Councillors Goodwin and Embleton, a further sum of £50 was ordered to be paid, leaving the balance over pending experts' examination and report.

Fulham.—The Electric Lighting Committee having recommended that a deputation be appointed to visit the towns of Leeds, Warrington, Oldham, Brighton, Bedford, and Portsmouth, for the purpose of seeing the destructors in operation and inspecting the electricity supply works, and that Messrs. Baxter, T. Davies, Tapp, and Terry do form the deputation, and that the expenses do not exceed £100, the matter was discussed at some length at the meeting of the Vestry. Eventually the report was referred back to the committee.

Catalogue.—We have received from the Universal Electrical Fittings Company, Limited, of Suffolk-road, Sheffield, their cata-

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logue. The 40 pages of the list are fully illustrated, and the catalogue is a well-turned-out production. The company claim for their apparatus that they are distinguished by a high and uniform standard of insulation and for their large contact surfaces. Special attention is given to service switches, main cut-outs, and junction-boxes, and provision is made for pressures of 200 volts or more at the consumer's terminals.

Acton.—The surveyor read a letter at the Urban District Council meeting from Mr. Goddard with reference to purchasing Mr. Cohen's electric lighting works, stating that if the Council intended to purchase the works they must take all risk. Mr. Cohen could only guarantee the rent of his own premises, 3, Emmanuel avenue. The matter lay in a nutshell: either the Council would or would not purchase the works, but his client could not be kept waiting for the Council's decision for an indefinite period. The letter was referred to the Works Committee.

Huddersfield.—A special meeting of the council of the Chamber of Commerce has been held to confer with representatives of other chambers of the West Riding, with a view to obtaining an improvement in the telegraphic service between West Riding towns and the London Stock Exchange. On the motion of Mr. Bentley, seconded by Mr. Hooper, it was resolved to suggest to the Postmaster-General that messages to and from the London Stock Exchange to the West Riding towns should be transmitted through the direct wire of the Leeds Stock Exchange.

Perth.—Permission having been asked by the National Telephone Company to erect a line of poles along the public road between Perth and Crieff, the Chairman remarked at the meeting of the District Committee that they had a standing agreement with the Telephone Company. Colonel Sandeman stated that if they granted the permission asked, and branch wires were attached to the line, Perth and Crieff, it would then become a trunk line and therefore become Government property. It was agreed to grant the necessary permission on the usual terms.

Blackpool.—The Electricity and Tramways Committee have rescinded the following resolution: "That 4½d. per unit be the amount to be charged the Corporation until further notice for public electric light arc lighting in the borough," and have resolved that the Corporation be charged on the same basis as other consumers for electric energy supplied by this committee's department for public electric light arc lighting. The profit from the Corporation's electric lighting undertaking for the year ended March 25, 1896, has been placed to a renewal fund account.

Wednesbury.—At the meeting of the Town Council, Councillor Joynson called the attention of the Highway Committee to the fact that the Walsall Corporation had taken steps to purchase the tramways in their borough. Councillor Oldbury, chairman of the committee, said he was aware of the action taken by Walsall in respect to their tramways. He understood similar powers to those possessed by Walsall existed in Wednesbury, and the Council might depend upon it that if anything was done seemingly to the detriment of Wednesbury he would at once call the committee together to protect their interests.

Montreal.—The Stilwell-Bierce and Smith-Vaile Company have secured what is stated to be the largest contract ever given for a turbine installation. This contract comprises the development of the water power on the Richelieu River, which forms the outlet of Lake Champlain. The development will amount to about 21,000 h.p., which is to be transmitted electrically into Montreal, some nine miles distant, where it will be sold for various purposes. The contract price for the hydraulic installation is 550,000dol. (£124,000). The turbine selected is the "Victor," of which Mr. F. Nell, of 97, Victoria-street, London, is the foreign representative.

Walsall.—A memorial, signed by 75 residents and property owners in High street and Digbeth, was read at the Town Council meeting, praying for the extension of the electric lighting scheme to those parts of the town. The Mayor said he sympathised with the memorialists, but the matter could not be settled at once, because various details would have to be considered. He proposed that the memorial should be referred to the Street Committee to report to the General Purposes Committee, and, if necessary, to the Council. Mr. Williams seconded the proposition, remarking that the memorialists were only anticipating the wish of the Council. The motion was agreed to.

The Cost of Current in the City.—At the meeting of the Court of Common Council, Mr. Brooke Hitchen asked the chairman of the Commission of Sewers whether he had placed before the members of that body the question as to the desirability of approaching the electric lighting company with a view to its reduction of the cost of the electric current? Mr. Turner, in answering in the negative, said the citizens had the matter in their own hands, as if they combined and said they would not use the current unless a reduction was made in the cost the company could do nothing else. As regards the public lighting, the Commission had made, he thought, an excellent bargain.

Redditch.—A letter was read at the meeting of the Urban District Council from the Manchester Edison-Swan Company stating that they proposed to apply to the Board of Trade for a provisional order authorising them to supply electricity for lighting and other purposes in the district, and asking their permission to make the application. Some time ago the Local Board caused an enquiry to be made and an estimate prepared of the cost of lighting the town by electricity, but no definite steps were taken in the matter. The opinion was generally expressed that if electric lighting was introduced the Council should undertake the work themselves, but the further consideration of the subject was deferred.

Forfar.—At a meeting of the County Road Board the County Clerk stated, in connection with the arrangement for the transfer of the trunk wires from the National Telephone Company to the Post Office, that the County Council assessor had these under consideration. He had been instructed to communicate with the clerk of that body, as well as with Lord Camperdown, and at the same time petition the Postmaster-General, requesting that in connection with county matters the same facilities be afforded as hitherto. Consideration of an application by the National Telephone Company for permission to lay an underground cable from Dundee to the Strips of Craigie was delayed until a report had been received from the Dundee District Committee.

Waterford.—At the meeting of the Corporation a letter was read from the secretary of the General Post Office, London, informing the Council that their resolution calling for an extension of the trunk telephone trunk system so as to put Waterford into direct telephonic communication with Dublin and Cork, would receive careful consideration from that Department. Mr. John E. Redmond, M.P., wrote acknowledging receipt of the resolution, and stated that it would give him great pleasure to aid in the effort now being made to extend the telephonic communication to Waterford. Mr. Power, M.P., also wrote and promised to confer with the gentlemen named in the resolution as to the best way to advance the views held by the members of the Council on the subject.

Leeds.—A meeting of the Highways Committee of the Leeds City Council has been held to consider a proposed agreement between the Corporation and the National Telephone Company for charges for way-leaves for wires, either overhead or underground, within the city. A special sub-committee, which had been appointed to discuss the matter, recommended that the company should be charged 2s. 6d. per subscriber for the first year, 3s. 9d for the second year, and 5s. for the third and subsequent years. An amendment was moved by Alderman Firth that the committee should enforce the Manchester terms, including 5s. per subscriber and 5s. per junction-box per year. The voting was equal, and therefore no decision was arrived at. The matter will again be considered by the committee.

Swansea.—It is now stated that in the new provisional agreement arrived at between the Corporation and the tramway company with a view of reviving what is known as the triple scheme, that so far from the company gaining any advantage the reverse is the case, the Corporation having secured the point on which it placed so much insistance—viz., complete control of the £32,000 which is to be advanced the company for the purchase of new plant, etc.—and it further gets the company to pay for the erection of transformers, estimated at £3 000. This is the point on which negotiations broke down six months ago. The company will be asked to pay for the transformed current. At a meeting of the Town Council, an amendment was passed that tenders be invited by advertisement for lighting the market by electricity upon the specification prepared by Mr. Manville, consulting electrician.

Bangor.—At the meeting of the City Council, Mr. W. P. Matthews moved that the resolutions of the Council dated October 9, 1895, and June 3, 1896, to apply to the Board of Trade for a provisional order for the electric lighting of Bangor be rescinded. He maintained that the Council would lose nothing by adopting his motion, because it was evident that no outsider could go in for a provisional order without the consent of the Council. Taking into consideration the expenses connected with the pier, the dredger, the infectious hospital, etc., he thought they should not incur further expenditure. He asked them to vote for his motion, as he believed the opinion of the majority of the ratepayers was against applying for a provisional order. The Mayor seconded the motion, but after a long discussion it was lost by 6 to 15.

Wilmslow.—On the recommendation of the Highway Committee, the Urban District Council have decided to oppose the application of the Alderley Edge and Wilmslow Electric Supply Company for a provisional order, and that the Council apply to the Board of Trade for a provisional order under the Electric Lighting Acts, 1882 to 1888, for supplying the district of Wilmslow with electric energy; that the clerk act as the Council's solicitor, and be instructed to prepare the application, plans, notices, and take all necessary steps for the purpose of the application, and engage a consulting electric engineer if required. Mr. Pearson said if they sanctioned the provisional order being proceeded with, it did not follow that they laid down the plant to work the district. He understood they were not going to put plant down until electricity could be produced at a considerably reduced cost.

National Telephone Company.—The directors have resolved, subject to final audit, to recommend at the forthcoming general meeting the following dividends for the half-year ending June 30 last: at the rate of 6 per cent. per annum, less income tax, on the amounts paid up on the first and second preference shares; at the rate of 5 per cent. per annum, less income tax, on the amounts paid up on the third preference shares; at the rate of 5 per cent. per annum, free of income tax, on the amounts paid up on the ordinary shares, being the same dividend as was paid in respect to the corresponding half-year of 1895, carrying the same amount to reserve—namely, £35,000—and about £17,000 forward, as against £3,907 last year. The transfer-books of the Company will be closed from the 17th inst. to 30th inst., both days inclusive, and the dividend warrants will be posted on the latter date.

Torpedo-Boat Destroyers.—H.M.S. "Swordfish," one of the torpedo-boat destroyers built by the Elswick firm and engined by C. E. Belliss and Co., Limited, of Birmingham, has passed with great success her dockyard official full-power trial at Chatham, the average power developed by the machinery being 4,359 i.h.p., or

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about 10 per cent. above the contract. When it is borne in mind that the total weight of the engines and boilers only amounts to 56lb. per i.h.p. against 400lb. in the fastest Atlantic liners, the care required in designing and working with such reduced factors of safety as is necessary in these vessels will be better appreciated. The full run was made from the Maplin Sands towards Harwich and back, and concluded with circle turning at full and half power ahead and astern, and throughout the whole of the trial there was not the slightest hitch of any sort with the machinery and boilers.

Wrexham.—At the Rural District Council meeting a letter was read from the town clerk of Wrexham respecting the request of the District Council for an idea of how far they were going to apply for powers to supply electric light outside the borough, and which arose through the Wrexham Town Council asking whether the District Council had any objection to their proposed application to the Board of Trade for a provisional order to provide the borough and its immediate vicinity with electric light. The Town Clerk, in his reply, said that the area had not been definitely decided, but he thought that for the present a radius of two miles would be near the mark. Mr. E. S. Clark and Mr. Ellis said they had installations at their works, and both objected to Wrexham bringing their installations into their district. Mr. B Davies proposed that the matter be deferred until they had the definite area before them, and this was adopted.

Bristol.—The Electric Light Committee have decided to lay a main from White Ladies'-road through Cotham-hill, Woodland-road, to Highbury Chapel and University College-road. A Local Government Board enquiry is to be held into the committee's application to borrow £75,000. The Town Council have given permission to the National Telephone Company to lay pipes containing telephone wires on certain conditions under the following streets—viz., High-street, Baldwin-street, St. Augustine's-parade, Denmark street, Unity-street, Park-street, Queen's-road, Westbourne-place, and Oakfield-place; Bristol Bridge, Victoria street, Thomas-street, Portwall-lane, and Temple-gate; Bath street, Philip-street, Narrow Plain, and Broad Plain; Maryleport-street, Peter-street, Castle Mill-street, Broad Weir, and Narrow Weir; Merchant-street, Old King-street, Barrs-street, North street, King square-avenue, and Jamaica-street—and to construct manholes at various points in the footways.

Boston.—At the Town Council meeting, Alderman Simonds moved that the Paving and Lighting Committee be appointed to enquire into the advisability of erecting an electric light installation for the purpose of serving the lighting requirements of the town and dock. He stated that practical experience had taught him that the electric light was not only far superior, but was very much cheaper than gas. Peterborough, with a population of about 25,000, had recently applied for a provisional order to expend £20,000 in providing electric light, and Shrewsbury, with 25,000 inhabitants, had lately spent a similar amount in like works. He pointed out that the price of gas in Boston was very much higher than in other towns At Sheffield 2s. per 1,000ft. was charged, at Hull 1s. 10d, at Lincoln 2s. 6d., and at Grimsby 2s. 6d, but at Boston the price was 3s. 10d., with no reduction to the Corporation, who were the largest consumers. Alderman Weightman seconded the proposition, and it was carried.

Dorking.—A letter was read at the Urban District Council meeting from the Guildford Electricity Supply Company stating that application was intended to be made, on or before December 21 next, by a memorial to the Board of Trade for a provisional order, to be confirmed in Parliament in the ensuing session, whereby it was proposed to authorise the company to supply electricity for any public or private purpose within the area of the Dorking local authority. The Chairman suggested that they should again approach the Dorking Gas Company and see if they could not come to some understanding with regard to incandescent gas lighting. The Council now felt that some definite steps should be taken to get a better light in the streets than they had had lately. His own view was that if they were unable to come to any satisfactory arrangement with the gas company, they should turn their attention to the electric lighting companies Mr. Chalcraft proposed that the chairman's suggestion be adopted, which was seconded by Mr. Wood, and carried.

Newington.—The Vestry have decided "that Messrs. Kincaid, Waller, and Manville be engaged for a fee of 50 guineas to prepare a report dealing with the system of electrical distribution best adapted for Newington, the capacity of the station, the capital cost, the distributing mains, the revenue reasonably to be derived, the cost of maintenance, statistics from all municipal undertakings to date, and all necessary assistance in making a fresh application for a provisional order should the Vestry decide to apply to the Board of Trade for same; and in the event of such application being made, and a provisional order sanctioned by Parliament, such fee of 50 guineas to merge into the usual 5 per cent. for preparation of plans, specifications, and supervision of works to be carried out under the order, it being distinctly understood that the only extra fees payable in excess of the agreed fee will be in respect of attendances in the event of a local Board of Trade enquiry, and the ordinary out-of-pocket expenses for telegrams, cab fares, postage, and such like expenses."

Northwich.—At the meeting of the Urban Council a letter was read from Mr. E. T. Ward, secretary of the Northwich Electric Light Supply Company, giving notice on behalf of that company of their intention to forthwith apply to the Board of Trade for a provisional order authorising the company to supply electricity for public and private purposes within the area of the Urban Council of Northwich. The Clerk said it was advisable to report what position the Council was in with regard to the service of the notice. He found that by the Act of 1888 the consent of a local authority was generally necessary before the Board of Trade issued a provisional order. Such orders, it is stated, were not to be issued without the consent of the local authority of the district unless the Board of Trade, under special circumstances, considered that such consent ought to be dispensed with. As to monopoly, none was created by the issue of a provisional order or license under that Act, therefore the Council might take it for granted that before the Board of Trade issued an order it would communicate with the Council.

Bacup.—At the quarterly meeting of the co-operative store, the sub-committee on electric lighting presented their report, in which they said: "Whilst admitting the advantage of electric lighting in having less depreciation in drapery, boots, and shoes, as compared with gas, less risk of fire, less injury to the health of the employés, and a saving in painting, cleaning, etc., we are, however, of the opinion that we should not at the present time be justified in saddling the society with what might prove a serious burden. The cost of an installation complete would, in round figures, amount to £1,000, and in working out the annual cost we find it to be as follows: interest on £1,000 at 5 per cent., £50; depreciation at 10 per cent., £100; repairs and renewal, £10; waste oil and water, £20; engineer, £70—total £250. The amount paid for gas lighting is about £220 per year, and the cost of working the gas-engines to make the electric light would be about the same amount, so that for 10 years we should be taxed with an extra £250 per annum over and above the cost of lighting with gas as at present. After very careful consideration, we recommend that for the present we do not adopt electric lighting."

Exeter.—The following recommendations of the Special Committee on Electric Lighting have been adopted by the City Council: "That two electrical assistants be retained at the works, one at £60 and the other at £52, with an improver at £20; a first engine-driver at £2 a week, a second driver at £1. 4s, and a foreman of outside work at £2. 2s., their working hours to be 56 per week; that the surveyor be instructed to provide a new set of ropes and other apparatus, and that he be empowered to carry out on his own responsibility repairs costing not more than £50; that the price quoted for the lighting of the hospital be 6d. per Board of Trade unit, with a 25 per cent. discount if a *bonâ fide* all-night supply was taken, and additional specified discounts; that the light be offered to the Post Office on special terms; that a 300-i.h.p. boiler, feed pump, steam alternator, and sundry apparatus be provided for the station at a cost of £2,100; that sufficient length of cable be obtained to put High-street, a portion of Queen street, Fore-street, South-street, and part of Sidwell-street on the large transformer circuit, the new cables to be laid under the footways on both sides of the thoroughfares to avoid cross-street openings and risk of damage." The estimated cost of carrying out the last-named recommendation was £1,325.

Warrington.—The Town Council have confirmed the action of the General Purposes Committee in instructing the town clerk to oppose an application for power to supply electrical energy to Warrington which an electric lighting company intended to make to the Board of Trade. Councillor Bennett thought the opposition to the electric lighting company was only justified on the assumption that the Corporation intended to provide electrical facilities themselves. One or two local tradesmen had gone so far as to instal electricity in their own premises Councillor Roberts said it was not the intention of the General Purposes Committee to allow any outside authority to come there and obtain powers for providing the electric light which the Corporation would afterwards have to buy at an enormously increased value Councillor Heaton said the Gas Committee were, if they had applications from a certain number of the inhabitants of Warrington, prepared to deal with the electric light. If Mr. Bennett and half a dozen other people with some substance about them would apply, they would be able to put them in the light. Alderman Sutton thought Councillor Heaton was quite right in saying that the Gas Committee would be prepared to undertake to put in the electric light if they saw the necessity for it. At present he was quite satisfied it would not pay to proceed.

London Lighting Extensions.—The London County Council have granted applications from the following companies: the House-to-House Company to construct small transformer-boxes in connection with mains already laid, to lay high and low tension mains in part of Warwick-road and in Nevern-square, and to construct four transformer street boxes in connection therewith, and to lay low-tension mains in Courtfield-gardens; the County of London and Brush Provincial Electric Lighting Company of intention to construct a large transformer-box in Burston-road instead of in the position previously sanctioned at the corner of High-street, Putney; the Charing Cross and Strand Electricity Supply Corporation of intention to lay mains in the Strand from Bull-inn-court to Burleigh-street, in Garrick-street and Great Newport-street to the subway in Charing Cross-road, in Mercer-street, Castle-street, and Neal-street. The Highways Committee's report stated that it had been represented to them that it would be a convenience to the House-to-House Company if, instead of the one month's notice required by its respective orders to be given of new works, the Council would accept four days' notice with reference to the construction, in connection with mains already laid, of small transformer-boxes of the kind and size above specified. The committee saw no objection to this concession, which would, no doubt, facilitate the company's business, being made, and they recommended accordingly.

Hammersmith.—The Electric Lighting Committee reported at the Vestry meeting as follows: "That the engineer brought before us the advisability of the two large boilers to be supplied

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under Messrs. Ferranti's contract being fitted with superheaters, at an additional cost of £270. Although these were not provided for in the original specification, the engineer now reports to us that, in his opinion, by the use of these superheaters there will be a great saving in the coal consumption, perhaps some 15 to 20 per cent., and as in all probability they would in a year or two have to be provided, we recommend that the Vestry, acting under the advice of the engineer, do sanction the extra expenditure on Messrs. Ferranti's contract." Mr. Searle moved the adoption of the report, and in answer to a member as to why it was that the advantage of superheaters had not been found out before, he replied that they were not included in the original specification because the experience had not been gained that they had at present. The results of the experiments had shown the great advantage that was to be gained by the use of these superheaters. The engineer was perfectly certain that they would be a great saving to the parish, not only in a less consumption of coal, but also in saving the machinery a great deal. The committee's report was adopted. The Finance Committee recommended the Vestry to apply to the London Council for their sanction to the borrowing by the Vestry and for the advance of £41,046 for the electric lighting and other purposes. This was agreed to.

Appointments Vacant.—The Commissioners of Sewers require a resident engineer to look after the Central London Railway works The appointment is a temporary one at £6 a week and application must be made to the clerk of the Commissioners before Monday.—The governing body of the Northampton Institute, Clerkenwell, E C., invite applications for three appointments. The first is for a head of the department of mechanical engineering and metal trades, salary £250 per annum; the second is for a head of the artistic crafts department, salary £250; and the third is for a chief assistant in the department of applied physics (including electrical engineering); salary £180 per annum. The appointments will date from October 1 next, and applications are to be sent in to the principal, Mr. R. Mullineux Walmsley, D.Sc., not later than 10 a.m. on Tuesday, July 28.—The Corporation of Londonderry invite applications for the post of dynamo attendant, which are to be sent in to Mr. R. P. Chambers, town clerk, not later than Monday, 27th inst.—The Plymouth Corporation invite applications for the post of draughtsman and assistant to the borough electrical engineer. Applicants must be over 25 years of age. The person appointed will be required to devote his whole time to the service of the Corporation. Salary £150 per annum, rising by annual increments of £10 to £200. Applications, accompanied by copies of not more than three testimonials, and endorsed "Assistant Electrical Engineer," must be delivered to Mr. J. H Ellis, town clerk, not later than Thursday, the 30th inst. Further particulars of these appointments can be seen in our advertisement columns.

Wolverhampton.—The Lighting Committee have presented their report on the working of the undertaking to the Council. The report states: "Your committee have delayed presenting the accounts of the year ended March 31, 1895, until the accounts for the year 1896 were completed, as at the former date the supply of electricity for public lighting and private purposes had only been in progress for two months, and the accounts for so short a period would have been of little value to the Council, and no guide as to the results of the undertaking from a commercial point of view. The operations of the year ended March 31, 1895, resulted in an adverse balance of £1,162. 4s. 9d., but it must be pointed out that the accounts for this period were debited with interest on capital, and also with a sum of £868 3s. 6d., representing one year's instalment to the sinking fund in respect of capital, whilst the receipts for electricity supplied only extended over a period of two months. As regards the accounts for the ended March 31, 1896, the revenue account shows a credit balance of £1,570. 2s. 8d., which represents 4·85 per cent. on the borrowed capital. The expenditure in respect of interest on capital and contributions to the loans fund sinking fund amounted to £1,811. 7s. 2d. The loss for the year has therefore been £241. 4s. 6d., as shown on the net revenue account. Your committee view these results with satisfaction, and have no hesitation in saying that the undertaking will, in due course, prove a source of profit to the Corporation. It is proposed to carry the balance forward, and to meet the same out of future profits of the undertaking, so that there will be no necessity to ask for a rate in aid."

Hampstead.—The report of the Lighting Committee at the meeting of the Vestry recommended that additional high-tension feeders be laid down from the central station to a number of sub-stations at an estimated cost of £787. 14s. 2d. for cable, and that a supplemental water supply be provided to the station by means of a 4in. supply main from the bottom of Arkwright-road at an estimated cost of £155. This was adopted. The same committee reported that they had instructed the engineer to adapt one of the existing street gas lamps for incandescent electric lighting and try the same as an experiment; that they had instructed the engineer to try the effect of using Welsh coal at the station for a period of 14 days; that they had empowered the engineer to procure a coal-weighing machine at an estimated cost of £10; and that they had given instructions for a clerk of works for the extension of the central station to be appointed, and had left the selection to the chairman of the committee and the architect. This was approved Mr. E S. Payne moved, "That it be referred to the Lighting Committee to report as to the cost of lighting by electric arc lamps the High-street and parts of Rosslyn-hill and Heath street and to bring up a recommendation thereon " He remarked that of recent years the arc lamps had been very considerably improved, and many of the trading centres of the Metropolis were being lighted by means of arc lights. Islington was doing it, St. Pancras had done it, and he thought Hampstead should do it. Mr. Greenhill said he did not object to the motion, but thought that the reference should extend to the whole of Haverstock-hill. Mr. C. H. Reed, chairman of the Lighting Committee, said that the committee had the whole subject under consideration, but had deferred their report until after the summer vacation. The Chairman said that, this being so, the motion and amendment were both out of order, and the discussion therefore ended.

Whitehaven.—Councillor Musgrave, in moving the adoption of the Lighting Committee's minutes at the Town Council meeting, said it must be satisfactory to know that their faultage had been satisfactorily reduced. On the subject of the Siemens's contract and the point in dispute, Dr. Hopkinson had arrived at the conclusion that in regard to the relaying of the substituted main conductors by the contractors, the Council should be at the expense of opening the trenches. The committee, however, were unanimous in considering this a wrong view of their contract with Messrs. Siemens. But the engineer had the matter in hand, and he, in his wisdom, had given a certificate that they were to be at the expense of opening the trenches. The town clerk was of a different opinion, and the committee did not arrive at his view without making an effort to put the matter right. At the present time they had expended £205 of the ratepayers' money in wages in opening the trenches, and they must be aware that there was a great deal of work to be done before the whole of the cables could be relaid. They considered when they opened up the trenches in the first instance at their own expense to receive the cables that they honourably performed their part of the contract. That was the position of the committee, and they maintained that Messrs. Siemens and Co. had adopted that view, because the firm in cases where there had been failures in different parts had asked them to open the trenches, and had actually already paid them for doing so in every instance So that it was practically an admission that the contention of the committee was a correct one. Councillor Barr seconded. Councillor Dickinson wanted to know if the Council were not more to blame than the contractor. This at least was his opinion. He further desired to know if, when the wire was first put in, an inspector was appointed, because he could never ascertain the fact. The Deputy-Mayor: The work was certainly inspected as it was done Councillor Dickinson said that as regarded the action of the Council, he held that they had made a mess in taking the work into their own hands. The contractor should have been allowed to complete his own work. The minutes were adopted.

The Blackwall Tunnel.—The following report from the Bridges Committee was presented at the last meeting of the London County Council: "We have to report that for some months past we have been considering the question of lighting the Blackwall Tunnel, and that we have come to the decision, after inspecting the tunnel, that electricity is the best and cheapest form of lighting. The continuous requisition of the light both day and night will require a uniform supply which will greatly decrease the cost per unit The cost will reach £25,000, which includes buildings, subway, plant, mains, and lamps for the light at 10ft. centres, and will be paid out of the £50,000 provision money which has been set apart for work of this description. We have given directions for the buildings for the generation of the electricity to be erected on Northumberland Wharf, Poplar, as it is the most convenient site for the purpose and have agreed to use No. 2 shaft on the wharf for tunnel purposes only. With regard to the prices for the buildings, we have arranged with Messrs. Pearson and Son, the contractors, such terms as we think are favourable to the Council. With regard to the plant and machinery, the specification is well in hand, and the necessary drawings are being prepared, and we anticipate that the working of the installation, exclusive of depreciation, repairs, and capital charges, but including lamp renewals, will be about £5,000 a year. We have arranged for three lines of lights in the tunnel, and each line to be controlled independently at the engine-room switchboard. The surface and sunk approaches will have a line of lights on each side as in ordinary street-lighting; this will reduce the attendance for lighting and extinguishing the lamps to a minimum. With regard to obtaining the plant, we are of opinion that the best course to take is to obtain tenders from a few selected firms, as it is necessary that the plant to be supplied should be of the highest excellence. As the Council is about to adjourn for the summer vacation, and as the work must be proceeded with without delay, we recommend that the Bridges Committee be authorised to invite and accept tenders for the plant required in connection with the lighting of the Blackwall Tunnel, and that the operation of standing order No. 178 be suspended accordingly."

Torquay.—Colonel Durnford, R E., has held an enquiry on behalf of the Local Government Board concerning the Town Council's application for leave to borrow £23,000 for electric lighting works. Mr. Percy Pearce said the provisional order sanctioning the supply of electricity was obtained in 1891. It would be unwise and foolish of the Council to delegate their powers to a private company. No less than 51 corporations were already supplying electricity, and 25 corporations were about to start supplies. There were innumerable private companies who were seeking for the powers of the Council in the matter. That was one of the strongest possible arguments for the position taken up by the Council, because private firms would not be so anxious to take up the scheme if it would not be a financial success. There had been only four boroughs who had undertaken electric lighting and had parted with their schemes to companies, and at least two of them had reason to regret their folly. At Cambridge and Dover (two of the towns alluded to) the companies were making large profits. He believed the growth of the demand in Torquay would be as great as in other towns. There was abundant justification for that, seeing that Torquay was so frequented in winter.

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They had exceptional facilities for supplying the light, seeing that the building was provided. The Town Clerk said they had been continually receiving applications from private companies who were seeking to exercise the powers of the Corporation in the matter. The Guildford Electricity Supply Company had given notice of application for a provisional order, and a firm of electrical engineers at Taunton had asked the Council what they intended to do, as residents at Torquay had consulted them with a view to putting in electric plant. A canvass of traders was made concerning the taking in of the light with most encouraging results. Mr. W. H. Trentham, M.I M E, said that he had had 20 years' experience as an electrical engineer. There could be no doubt that the high-tension system was most suitable for Torquay, partly on account of the extreme length of the compulsory area, also on account of the character of the Lincombe and Warberry districts. The houses being so far apart rendered the cost of low-tension mains out of all proportion to the revenue to be derived therefrom. He estimated the cost of the plant for 4,000 16 c.p. lamps and 70 arc lamps at £22,000. The revenue per annum, charging the current at 6d. per unit, and taking the consumption at the very moderate rate of 13 units per 30-watt or 8-c p lamp, would amount to £4,322, or, adding £519, the cost of gas lamps in roads and pier. the total revenue, with £150 for meter rents, would be £4,991. The cost of electricity at 6d. per unit was approximately the same as gas at 4s. 5d. per 1,000ft., but in actual practice it was found equal to gas at 3s. per 1,000. Other evidence was taken and the enquiry terminated.

PROVISIONAL PATENTS, 1896.

JULY 6.

14946. Improvements in insulating electric conductors. Willoughby Statham Smith and William Puddicombe Granville, 24, Southampton buildings, Chancery-lane, London

JULY 7.

14993. The external walls telephonic connection. Frederick Jones, 76, Wakehurst road, Clapham Junction, London.

14996. Improvements in and connected with automatic or thermostatic fire-alarm telegraph systems. William Edwin Heys, 70, Market-street, Manchester (Joseph W. Frost, United States.) (Complete specification.)

15006. Improvements in phonographs. Paul Constant Amans, 8, Rue des Princes, Brussels.

15013. Improvements in electrical selectors and answer-backs. Theodore McKenna, 17, Basinghall street, London (John Mowe Drysdale, United States.) (Complete specification.)

15031. Improvements in dynamo-electric machines and methods of compounding the same. The British Thomson-Houston Company, Limited 70, Chancery-lane, London. (Charles P. Steinmetz, United States.) (Complete specification.)

15072. Improvements in or relating to phonographs. Horatio John Heinze 111, Hatton garden, London.

15074. Improvements in or relating to electrically-ignited torches, cigar lighters, or the like. John Hencken and John Henry Meyer, 111, Hatton-garden, London. (Complete specification.)

15078. Method of and means for recording in connection with electricity supply. Arthur Marston Billington, 46 Lincoln's-inn-fields, London.

JULY 8.

15102. Improvements in the method of winding armatures for multipolar continuous-current dynamo-electric machines and electromotors. Frederick Henry Royce and Ernest Alexander Claremont, 53, Arcade-chambers, St. Mary's gate, Manchester. (Complete specification.)

15129. A process and apparatus for effecting electrolysis. Frederick William Golby, 36, Chancery-lane, London. (Otto Arlt, Germany.) (Complete specification.)

15162. Improvements in electric meters. Siemens Bros. and Co , Limited, 28, Southampton-buildings, Chancery lane, London. (Siemens and Halske Germany.)

15176. Improvements in or connected with dynamo-electric machines for use in what is known as the three-wire system. James Yate Johnson, 47, Lincoln's-inn fields, London. (The Elektricitäts Aktien Gesellschaft vormals W. Lahmeyer und Co., Germany.)

JULY 9.

15223. Improvements in or relating to the production of electricity. Hugh Fitzalis Kirkpatrick-Picard, 111, Hatton-garden, London.

JULY 10.

15292. Improvements in arc lamps. Annie Taylor Schmidt and Frederick Thomas Schmidt, 12, Cherry-street, Birmingham.

15303. Improvements in the method of and means for protecting electric lamp fittings from damp and corrosion and for preventing short-circuiting. Joseph Lomax Kendal, 5, John Dalton-street, Manchester.

15318. Improvements in apparatus for the ignition of hydrocarbon and other gases by electricity. Max Byng and Leopold Dowland Cole, 73, St. Stephen's-road, Upton Park, London.

15321. Automatic switch for sending the current always in the same direction through the whole or some part of the circuit independent of the current in the main. William Booth, 98, Clerkenwell road, London.

15322. Converter for changing continuous into alternating current to be used in connection with transformers. William Booth 98, Clerkenwell-road, London

15326. Improvements in insulating and supporting electric wires intended to act as electrical resistances applicable as radiators of heat for cooking, warming, and other purposes. Rookes Evelyn Bell Crompton and Edmnd John Fox, 55, Chancery-lane, London.

JULY 11.

15380. Improvements in the means of connecting branch electric light wires to the main or line wires. Samuel Scargill and Albert Hanson, 2, Market street, Bradford.

15433. An improved preparation of electrolyte for use in semi-dry primary or secondary electric batteries. Henry Weymersch and Arthur McKenzie Cardwell, 47, Lincoln's inn fields, London.

SPECIFICATIONS PUBLISHED.

1895.

11708. Electric switch apparatus. Pippette.

12042. Globes for arc lights, etc. Jandus.

13091. Electric switches. De Ferranti.

14066. Dynamos and electromotors. Parsons.

14739. Incandescent electric lampholders. Huisman and Gover.

14902. Secondary battery plates. Fabbro.

15260. Electromagnetic separators. Robinson

15338. Arc lamps. Barnett.

15442. Suspending electroliers, etc. Faraday.

15450. Electric telegraphs. Roos and others.

15826. Insulating electric cables. Hardingham. (Felten and Guilleaume.)

1896.

7834. Electric railways. Krotz and others.

9650. Electromotors and dynamos. Lanhoffer.

10189. Electromotors and dynamos. Royce and Claremont.

10804. Electric railways. Lake. (Johnson and another.)

10818. Electric tramways. Devonshire. (Potter.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5¾-6¼
Brush Company, Ordinary	3	1⅛-1⅜
—— Non. Cum., 6 per cent. Pref.	2	1⅛-1⅜
—— 4½ per cent. Debenture Stock	100	112-116
Charing Cross and Strand	5	8¼-8¾
Chelsea Electricity Company	5	7¾ 8¼
—— 4½ per cent. Debentures	100	114-116
City of London, Ordinary	10	14¼-15¼
—— 6 per cent. Cumulative Pref.	10	16¾-17¼ xd
—— 5 per cent. Debenture Stock	100	133-137
City and South London Railway, Consolidated Ordinary	100	44-46
—— 4 per cent. Debenture Stock	100	135-137
—— 5 per cent. Pref. Shares	10	4¾ 15¼
County of London and Brush Provincial Co., Ordinary	10	8¼-9¼
—— 6 per cent. Cum. Pref.	10	13-13½ xd
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
Edison and Swan United Ordinary	3	1¾-2¼
—— 4½ per cent. Debentures	100	103-106
Electric Construction, Limited	2	1¼-1½
—— 7 per cent. Cumulative Pref.	2	2½-3
Elmore's Copper Depositing	2	[illegible]
Elmore's Wire Company	2	[illegible]
W. T. Henley's Telegraph Works, Ordinary	10	17½-18½
—— 7 per cent. Preference	10	17-18
—— 4½ per cent. Debentures	100	109-114
House-to-House Company, Ordinary	5	4-4½
—— 7 per cent. Preference	5	8-8½
India Rubber and Gutta Percha Works	10	21-23 xd
—— 4½ per cent. Debentures	100	106-108
Isle of Man Electric Trams, Ordinary	1	1⅜-1⅝
—— 6 per cent. Preference	1	1⅛-1⅜
Kensington and Knightsbridge Ordinary	5	9¼-9¾
—— 6 per cent. Pref.	5	7½ 8
Liverpool Electric Supply, Ordinary	5	8-8½
Liverpool Overhead Railway	10	14-14½
—— 5 per cent. Pref.	10	17⅛-17⅝
—— 4 per cent. Mortgage Debentures of £100	100	112½-114½ xd
London Electric Supply	5	1-1½
Metropolitan Electric Supply	10	12½-13½
—— 4½ per cent. First Mortgage Debenture Stock	100	119-121
National Telephone, Ordinary	5	7⅜-7⅞
—— 6 per cent. Cum. First Pref.	10	17-19
—— 6 per cent. Cum. Second Pref.	10	16-17
—— 5 per cent. Non. Cum. Third Pref.	5	6⅞-7⅛
—— 3½ per cent. Deb. Stock	100	105-108
Notting Hill Company	10	10-10½
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8¼-8¾
—— £4½ shares	4½	7¼-7¾
Oriental Telephone and Electric Company	1	¾-⅞
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	105-107
Southampton Electric Company	5	4¾ 5¼
St. James's and Pall Mall, Ordinary	5	11¾-12¼
—— 7 per cent. Pref.	5	9½-10½
Telegraph Construction and Maintenance	12	37-40 xd
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary		8-8½
Westminster Electric Supply, Ordinary	5	10½-11
Yorkshire House-to-House	5	7⅜-7⅞

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NOTES.

Spanish Cables.—The steamer "Dacia" has recovered and spliced the broken cable from Cadiz to the Canary Islands. The Ceuta cable has been repaired same time.

Steam-Engine Efficiency.—Prof. D. S. Capper and Mr. Henry Davey have been added to the committee appointed by the Institution of Civil Engineers to consider the question of a standard or standards of thermal efficiency for steam-engines.

British Institute of Public Health.—Yesterday (Thursday) was the opening day of the congress of the British Institute of Public Health at Glasgow. The inaugural address is delivered by the Lord Provost (Sir James Bell), and Prof. Ramsay, F.R.S., delivers an address as president of the chemistry and engineering section.

The Electrophone.—By way of an experiment, Dr. Jameson's trial has been laid on by the Electrophone Company to their offices in Gerrard-street, W. It may some day be an interesting point for the lawyers whether a person is to be considered legally as having heard a witness's statement in court when he was really a mile or two away at the time.

Telegrams in Italy.—According to the official returns of the Italian Ministry of Posts and Telegraphs, the number of messages sent over the wires during the last half-year of 1895 was 22,002,206. This includes despatches on the Red Sea line (Massowa and Assab). The revenue was about £27,500, no allowance being made for Government or service messages.

Society of Chemical Industry.—The annual London meeting of the members of the Society of Chemical Industry was brought to a close last Friday. During the day visits were paid to the Royal Arsenal, Woolwich, the ordnance factories, and the electrical and telegraph cable works of Messrs. Siemens Bros. at Charlton, and in the evening the members and a number of other gentlemen dined together at the Hotel Cecil. Mr. Thomas Tyrer (president) occupied the chair.

Motors for Printing Work.—In reference to employment of electromotors supplied by the town mains for the purpose of working printing presses, which has been mentioned elsewhere in this journal, it may be worth notice that at the last meeting of the Swansea Town Council an application to take two wires across High-street was made on behalf of Mr. J. C. Howell, it being stated that the object was to make experiments in driving the machinery at the office of the *Daily Post* by means of current from the electric lighting station in the Arcade. Permission was granted for three months.

Magazine.—We have had forwarded to us the August number of the *English Illustrated Magazine*, naturally looked to find if it contained something relating specially to electrical work—not with any great success. Mr. Marquardt, one of the survivors, contributes an account of the loss of the "Drummond Castle." Though the smashing of the ship on the rocks stopped the big engines at once, the electric lighting plant ran on to the last. "The bow sank and put out the fires; the electric lights suddenly blinked out. Immediately after, I found myself in the water, the ship having slipped off into the water right beneath me." The magazine seems a decidedly good sixpennyworth.

Tramcar Fenders.—The City Council of Oakland, California, have demanded that every street-car company in the city shall properly equip its cars with fenders, and they intend to enforce the demand. An ordinance has stood on the statute-books of the city for years past requiring that all street-cars should have life-saving fenders attached, of a pattern that should satisfy the Council; but, like a good many other ordinances, no one took any notice of it, till car ran over a few children and killed them. Several of the car companies have submitted plans of fenders, but the design which seems to meet with most satisfaction is that already in use on the Oakland, Alamada, and Piedmont Electric Railway, and which is the invention of a Mr. Clarke, of Alamada.

The Telegraph Congress.—As a result of the International Telegraph Congress at Budapest the new clauses are to be added to the international telegraph statutes, to the effect that the senders of telegrams to unknown addresses shall be informed that the addressee cannot be found. If the receiver of a telegram with answer prepaid does not send a reply the original sender can claim within three months the amount paid for an answer, and information respecting the delivery of a telegram, which hitherto has only been given by wire, may be furnished to the sender through the less expensive channel of the post, and, lastly, telegrams, if desired, will be sent after the receiver, in the case of a new address, in the same way as letters. The congress closed on Tuesday.

Labour Troubles.—A strike has been started at Messrs. Thorneycroft's works at Chiswick owing to the Boilermakers' and Iron Shipbuilders' Union and the Amalgamated Engineers being unable to agree whether a rivetter of iron plates or a fitter is the proper man to do tube work on water-tube boilers. As the fitters would go on strike if the boilermakers did the work, and the boilermakers would go on strike if the fitters did the work, and as both would strike if anyone else did the work, there is no other prospect than that work will be stopped indefinitely, as it is practically impossible to carry on the work of the yard and shops without members of both unions. Meanwhile, it is stated, there are contracts pending with penalties for delay. Though these are often covered by strike clauses it is not always so, and foreign purchasers especially are getting every year more shy of admitting the strike clause in English contracts. Looked at from their point of view it is not surprising.

Central Technical College.—The diploma of associate of the City and Guilds of London Institute has been conferred on the following matriculated students who have this year successfully completed a full course of instruction at the City and Guilds Central Technical College: civil and mechanical engineering—W. Gore (Siemens medal), V. Cooper, A. M. MacColl, J. S. Wilson, B. Price, D. H. Bayley, R. F. Baker, I. Barry, M. G. Weekes, C. E. H. Salmon, L. Temple, D. J. Jaffe, H. J. Saunders, H. M. Kirkby, J. A. Jones, A. Kenrick, A. B. Buckley, G. S. Perry, G. P. Mair; applied physics and electrical engineering—E. Ray (Siemens medal), C. A. Taylor, I. Braby, G. A. Maquay, G. W. D. Ricks, P. A. Tucker, E. Morgan, Y. V. E. Watlington, C. Barber, P. F. Rigden, J. F. Collard, W. Phillips, J. F. Pringle, C. E. Vance, H. J. Gridley, H. F. Hesse, M. J. Scears, W. F. Daniel, W. Steuart; applied chemistry—T. M. Lowry, E. F. Renwick, T. H. Pope, W. S. Gilles, A. J. Shelton, N. F. Deerr, H. C. Sayer, S. G. S. Panisset.

Motors in the Dairy.—The Devonshire people are reported to have invented the idea of heating the milk to make the cream rise — hence that interesting native product, clotted cream. Nowadays centrifugal separators are used, and Mr. T. R. F. Bolitho, of Trengwainton, near Penzance, having indulged in a model dairy, has naturally put one of these down, and has added

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a *délaiteuse*. Possibly even English dairymen may require to be told that this is a machine for separating the buttermilk from the butter while the latter is still in the granular state. It is so far like the separator that it involves the centrifugal principle. To work these and other dairy machinery, Mr. Bolitho uses an electromotor driven by accumulators. Details are wanting, but it may be said that an electromotor direct-coupled would be an ideal mode of running a separator if current were obtainable on a farm. Usually it is not, and unless there are exceptional facilities for charging it is to be feared that the expense of the accumulators will more than counterbalance the advantages. But it must be remembered that the only other alternative is to get up steam twice a day to do, perhaps, less than half an hour's work—which is not economical—or to use horse gear, which is even worse.

Lamp Accidents.—Sir Arthur Arnold, the chairman of the London County Council, in his speech on Tuesday last, in which he reviewed the work accomplished by the County Council during the past year, devoted a good deal of attention to the fire brigade department. The expenditure in this department increased by £23,000 in the past year, and he estimates that it will continue to rise till the annual expenditure reaches about £200,000. A melancholy item noted in his speech was the fact that some 450 fires were caused by lamp explosions in the year, and that 45 people lost their lives in consequence. These totals in London only might make one wonder that the fire insurance companies do not take some action in the matter, particularly when one remembers their requirements in the subject of electric lighting. The Petroleum Committee held its last sitting for this session on Wednesday, when Mr. Paul Babcock, a director of the Standard Oil Company of the United States, gave evidence. Mr. Babcock said that illuminating oil was supplied to Germany, Holland, Belgium, Italy, China, Japan, Java, and South America which gave a lower flash-point than the oil supplied for the English market. In his opinion, if England were by legislation to raise the flash-point to 90deg., and the rest of the world were to follow her example, there would soon be an oil famine. There were comparatively few lamp accidents in America; but then the people there were very careful about their lamps, and would never think of using some of the English lamps.

The Metric System.—In the House of Commons Sir S. Northcote has asked the President of the Board of Trade if he would introduce this session a Bill to deal with the metric system, in order that chambers of commerce and other parties interested might have sufficient time during the recess to consider the proposals of her Majesty's Government on the subject, and Mr. Ritchie replied that he would be glad to introduce a Bill; but, of course, not with any intention of proceeding with it this session. The chambers of commerce no doubt know what they want, but the particular advantage of this course of proceeding does not appear very evident to an outsider. The joint authority of Mr. Herbert Spencer and the *Times* have given pause to a great many people who before were quite ready to let the change go forward. The advocates of the metric system would stand a much greater chance of success if they would agree upon the way in which the change should be effected, and settle such practical points as whether we are to adopt the system, names and all—in which case people will continue to think in yards and tons—or whether English names are to be taken whenever there is a measure that can be made to fit with a little stretching. Whether or not we shall ultimately be forced into the use of the metric system by the practice of the rest of the world may very reasonably be questioned, but this time the movement will come to nothing, except perhaps a permissive use—*i.e.*, a permission which no one will avail himself of. The pity of it is that we did not rationalise our own system while there was yet time.

Electric Trams and Electrolysis.—In the *Street Railway Journal* there is given an account of how a waterworks company in the United States got as far as an action for damages by electrolysis, and found they were wrong after all. It appears that in Omaha the Farmers' Loan and Trust Company, which had the waterworks in hand, became alarmed by the reports of certain experts regarding the effect of electrolysis on the pipes, and probably honestly believed that they were badly damaged. Suit was brought for 250,000dol. It was not an easy matter to prove absolutely to the contrary, as the pipes were all buried, and the particular point near one of the power-houses, which had not been properly connected, showed damage for a block or more from electrolysis, and had to be relaid, making it look, of course, as if the trouble might soon extend over a large territory. But by great good luck it happened that in compromising some other matters with the city and insurance people, the waterworks company agreed to relay with larger pipe nearly all its mains in the business part of the city. This was all done last year, and, of course, the uncovering of the pipes in all that district which was thickly covered with street railway lines was watched with intense interest by all parties concerned. Experts from both sides were constantly on hand. The result was satisfactory to everybody, as it was clearly developed that there was no electrolytic action except at one or two spots, and even there it was doubtful whether it was electrolysis. It was but natural when the waterworks people found that they had practically no grounds for damages that they should ask to have the suit dismissed, as they probably felt that the slight injuries they had sustained could be adjusted without recourse to the courts. This is the first action that has ever been brought in the United States on this ground, and our contemporary naturally congratulates the electrical industry on the result.

Telephones in Russia.—It has been determined that the telephone line which was put up between St. Petersburg and Moscow on the occasion of the recent coronation festivities shall be allowed to remain, and shall be available for use by the general public. On the subject of the development of telephonic communication in Russia, the *St. Petersburger Zeitung* says that the introduction of the telephone exchange system dates from 1882, when concessions were granted to a company for the establishment of telephonic systems in St. Petersburg, Moscow, Warsaw, Odessa, and Riga. There were several concessions to companies or private undertakers in the succeeding years, and in 1884 the first Government system was established at Kief, though there had been previous installations in connection with the St. Petersburg palaces. After that progress was rapid, so that by 1895 41 additional town systems had been established, and at present all the larger towns of the empire are provided with a properly-equipped exchange As to subscribers, the list is naturally headed by St. Petersburg, with 2,230 in July, 1895; but as the number the year before was 1,977, there has probably been a considerable increase by this time. Such places as Baku and Nishgorod have 502 and 367 subscribers; the smallest is Berdiansk, with 30 only. The aggregate for the empire was, in 1895, 9,007 subscribers on companies' and 6,111 on Government systems, while the corresponding figures for the previous year were 8,004 and 3,958. This shows a considerable augmentation, and there has been a corresponding increase in the length of lines during

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the year. Trunk-line work is naturally more backward, since the distances in Russia are so much greater than in other European countries. The trunk lines between Rostoff and Taganrog and Odessa and Nicolaieff may be mentioned. Besides all that have been referred to above, there are, of course, a quantity of purely private telephone installations serving factories and so on, but not connected with any central exchange.

Motorcarts.—Cyclists say that the cabbies make a dead set at them, so it is not altogether surprising to hear of hostilities against motorcarts. Last week, John Harlow, a Margate cabman, was charged before the local magistrates with attempting to damage a motorcar and endangering the lives of the passengers. Mr. Alfred Cornell, the owner of the car, said that the defendant overtook him, whipped his horse furiously, and tried to pull it on to the car, but the animal backed away from it. He got into a place of safety, but for half an hour the cabman drove to and fro trying to get at him and threatening him. Defendant said he merely put up his hand for the car to stop, as his horse was frightened. This seems considerably to exceed the usual conflict of evidence in a running-down case, but as the magistrates imposed a fine of 26s., it is to be presumed that they did not believe the cabman. The motorcart is illegal at present, but it has its rights, and must not be smashed at sight. The Britannia Motor Carriage Company has held its statutory meeting, and the chairman has explained the reasonableness of giving the weight of the motor and omitting to say anything of the battery necessary to drive it. Sanguine views appear to be professed on that Board as to the technical knowledge of the average investor and his ability to draw inferences. An admirer of the Britannia motorcart who has seen it says there is "no smell of oil or steam or heat, and it does not in any way resemble a traction engine or an animated bathing machine." The inference is somewhat unkind to the other motorcarts at the Imperial Institute. The mention at the meeting of primary batteries as a source of power does not impress us favourably. We should advise the shareholders to have the motor they have bought unseen inspected by some independent expert before the capital subscribed has been spent. Lastly, Messrs. McDonald Bros., of Strathsay, are reported to have a motorcart which is to weigh 3cwt. complete, including the batteries. The motor is a ¾-h.p. one, and worm gearing is used. When it comes to pass that every town in the kingdom has a public electricity supply on the continuous-current system, and you can get your accumulator charged as easily as you can bait your horse, there will doubtless be a great future for the battery-cart.

Wave-Forms.—The New York *Electrical World*, which has reprinted in full Messrs. Beeton, Taylor, and Barr's Institution paper on the influence of the shape of applied potential-difference waves on the iron losses of transformers, says that the conclusions which it contains are important from a theoretical as well as practical standpoint. Our contemporary considers the paper most interesting on account of the method adopted of altering the form of the applied potential-difference wave by injecting at definite intervals a capacity or resistance. As to the effect of higher harmonics having various phase relations with the fundamental, while the resultants may have the same effective value and yet have areas differing by several per cent., it is doubtful whether the case of depressed waves deserves more than a theoretical consideration, inasmuch as such curves are not likely to be produced in self-inductive circuits without capacity. If the latter be present, it is considered that it remains undisputed that condensers work most effectively when supplied with either rounded or sine waves of applied potential difference. The higher efficiency obtained by the peaked form has been plausibly explained by Dr. Bell, by stating that the effect of superimposing upper harmonics is equivalent to increasing the frequency. Variable conditions of load may produce sufficient differences in the shape of the E.M.F. waves to make it practically impossible to predetermine the most effective form of wave which an alternator should produce, and for this reason laboratory results have a limited value when their application in commercial practice is considered. After comparing the advantages of peaked and rounded waves, it is concluded that as to the merits of the two types of waves, only specific cases can decide. The advantages which might be gained by the use of peaked waves in ordinary commercial alternating-current supply, although considerable, are of doubtful attainment, and our contemporary is quite of opinion that no great efforts will be made on the part of manufacturers to determine the best form of peaked E.M.F. which an alternator should have in order that it may apply more satisfactorily than the existing types to the conditions presented in widely differing cases. If that is so, then it seems to us all the more reason why every encouragement should be given to the undertaking of any work that may help to determine it in the laboratories of technical institutes or elsewhere. Even if no results capable of immediate utilisation are obtained, such work is always valuable in one way or another.

Accident.—Last week an accident happened at the City of London Company's City station which resulted in the death of a foreman named John Jackson Chisholme. From the proceedings at the inquest held by Mr. Langham, the City coroner, it appears that Chisholme was helping Mr. William Parry, chief tester at the company's works. Parry had instructions to make St. James's-square station "alive" from Crosby-square and to shut down St. James's-square main. The test that he and the deceased were making was with a Silvertown portable testing set, and the object was to enquire into the condition of the main before making it "alive." The deceased had taken the inner conductor or cable out of its terminus once without any accident, but he was repeating the operation when he suddenly shouted, and it was seen that he had received a shock. He was in a half-stooping position, but in answer to another assistant, who enquired if he was all right, he replied, "Yes, I think so." A second or two later, however, he fell back, struggled, and died. Chisholme was standing on an indiarubber mat at the time, but was not wearing indiarubber gloves, although these were provided. In reply to Major Cardew, who was present at the inquest, it was stated that if the deceased touched the "live" terminal it would mean a 2,000 volts shock. Another witness, Horace Howe, an assistant tester, said he was present when the accident occurred, and gave it as his opinion that the deceased fell, and to save himself placed one hand on the wall and the other on the inner terminal. He might have fainted or have been reaching his gloves, which were just above him. Mr. F. B. Aspinal, superintendent of the works, could only account for the fatality by the supposition that Chisholme touched the terminal and received a shock through not wearing gloves. Mr. Aspinal produced a set of rules which forbade high-tension switches, fuses, or cable ends in the transformer station to be touched or interfered with in any way whilst they were "alive." This was signed by the deceased as well as the other workmen. Mr. Aspinal also said he considered that a shock of 900 volts was sufficient to cause death. Less had been known to do it, and very much more had failed. Dr. F. Clark having given evidence, the coroner summed

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up, and the jury returned a verdict of "Accidental Death," adding a rider that the notice as to wearing gloves should be more extensively distributed at the works. This was not, however, the end of the matter, for the deceased's uncle got up in the court and made a statement as to certain remarks made by Chisholme, not to him, but to his wife. These amounted to the fact that the deceased had been apprehensive of neglect at the St. James's-square station, which would occasion danger to him. Upon this, the coroner allowed the verdict to be withdrawn and the inquest adjourned for further enquiry.

Electric Ploughs.—An illustration of Mr. Israel Hogeland's plough, to which reference has already been made in these columns, is given in the *Western Electrician* (Chicago) of July 4. The illustration is a process reproduction from a photograph, but, apart from the details of the motor and gearing, it is quite possible to form a fair idea of the machine. There are two shares of a nondescript shape and attached in a most primitive manner to the body of the machine, and no coulters whatever. In the illustration only one of the shares appears to be in use. Of course it depends on the depth of the furrow and the state of the ground, but this would agree with the statement that a 5-h.p. motor is used. The most striking thing, however, about the plough is the wheels. These are open ironwork constructions looking more like a river steamer's paddle wheels with rather short floats than anything else in the world. The object of these, of course, is to get a sufficient grip of the soil to overcome the resistance of the ploughshare. One of these wheels runs on the hard and the other on the already ploughed land, and must necessarily go over it more than once. What a "stetch' of stiff Essex wheat land would look like after Mr. Hogeland's plough had been over it must be left to the imagination. Probably the plough would not go, and certainly if it did it would carry a great deal of the land with it. At present, in steam ploughing the plough is strung on a wire rope, and hauled across the field and back by two engines. The friction and waste of power is enormous, and the wear of the rope and the cost of replacing it very heavy. Nevertheless, a certain amount of work is done that way on the contract system. If one engine only is used, the rope must go all round the field, with still more loss of power, and a complicated arrangement of "anchors" is necessary to take the strain at the corners. What is wanted is an arrangement by which the rope should remain still and the plough pull itself along it. The theoretical economy of this is evident, and experiments made many years ago showed that something a great deal more like an adequate return for the power expended could be obtained that way than is possible on the existing system. It remained only to construct a steam-engine of sufficiently light build to be able to run across a field without rendering it unploughable. The system was fully worked out, but was never carried into practice because the condition of agriculture did not appear to warrant the expenditure of the capital necessary. It would be an obvious improvement to keep the engine still as well as the rope, and the only practical way of doing this would be to carry the necessary energy to the plough electrically by means of a dynamo, conductor, and motor. On the other hand, the plough has simply been developed because horses and oxen cannot be taught to dig. A machine can be made to dig, and a digger does not require a rope to pull against. Moreover, digged land is better than ploughed land. The difficulty up to the present has been taking a heavy engine on to the land to work the digger. A comparatively light electromotor would be free from this objection. In one of these two ways the problem of mechanical cultivation will be probably solved some day. At present, however, it is doubtful whether either in Europe or America the situation is ripe for its introduction.

Isle of Man Tramways.—The opening of the Douglas Southern Electric Tramway took place on Thursday last week, and was favoured by magnificent summer weather, and large crowds assembled on Douglas Head to witness the inauguration. It was expected that the Mayor of Douglas (Major Stephen) would have performed the opening ceremony, but that gentleman was suddenly called away from the island, and his place was taken by Mr. G. W. Lowcock, the managing director. Before the trial trip was made the directors entertained a large number of guests at luncheon in the Villiers Hotel, Mr. W. P. Fawcus, one of the directors, presiding. Subsequently, the company were conveyed on beautifully equipped electric cars from Douglas Head to a point close to Port Soderick, the journey being accomplished to the entire satisfaction of the experts and visitors. On the return a stop was made at the power-house at Pigeon Stream, which the company inspected. The terminus at the Douglas end is under Douglas Head Hotel, but it is probable that in the near future the line will be extended to a point much nearer the town. The line is intended to open out the fine cliff and marine views of the isle, and the road is for the most part cut off the face of the cliffs, and follows the coast line from Douglas Head to Port Soderick. The length of the line at present constructed is 2¾ miles. The gauge is the normal 4ft. 8½in. of the English railways. The rails are of steel, 65lb. to the yard. The sleepers are also of steel, and, with the fastenings, weigh 55lb. each. All the ends of the rails at the joints have been connected with Chicago rail bonds. At present the line is a single one, with eight passing places. One of the features of the line is that there is hardly any straight piece in it, the route curving in and out as it passes through and over the headlands. There is not a level spot on the whole road, but the worst gradient is only 1 in 16. There are three bridges of 120ft., 240ft., and 110ft. in length respectively. The line is worked on the overhead system. The trolley wires are carried on steel poles with brackets, and a feeder runs on the poles for a distance of 1¾ miles. There are two trolley wires, one for the up and one for the down traffic, to simplify the arrangements at the passing places. The trolley wires are divided into half-mile sections, with a switch to each section pole, so that part of the line can be off if necessary. The generating station is at the Pigeon House Stream, and the plant is in duplicate, so that in the event of one engine breaking down there will be a second to fall back upon The rolling-stock, when completed, will consist of 12 cars and trailers. The cars already on the line are very like the cars which run between Ball's Bridge and Dalkey on the Dublin line. The work of constructing the line was carried out by Mr. H. L. Fletcher, resident engineer, and Mr. G. C. Pritt, assistant electrical engineer. Mr. J. J. MacMahon had charge of the overhead construction, and Mr. J. E. Winslow was chief engineer. The General Traction Company, Limited, are responsible for the work.

Electric Lighting in Odessa.—In an article on the progress of electric installations in Odessa the *Elektritschestwo* remarks that the development of electric lighting in that city dates from the year 1887. In that year the town theatre was built, and the authorities stipulated that it should be supplied with the electric light. The result was the erection of the first Odessa municipal generating station, containing two Ganz dynamos, supplying alternating current

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at 2,000 volts. Besides the requirements of the theatre, this station served about 600 incandescent lamps belonging to private consumers. In 1891 a second generating station was built and supplied with two of the Compagnie Continentale Edison's continuous-current 100-volt dynamos, with an output of 400 kilowatts each. The dynamos were driven by two Weyher and Richemond engines. This station is said to have cost 100,000 roubles, which probably means about £15,000 or £16,000, and for the first two years of working resulted only in a heavy deficit. At the end of 1893 both stations were leased to Mr. Morguliss, an engineer. He paid the town a rental of 25,000 roubles, and received back 20,000 roubles for lighting the theatre, and the town authorities also contracted to take of him current for 1,000 lamps at 35 copecks per kilowatt-hour, or 10 to 12 per cent. reduction on his tariff for private consumers. If the rouble is taken at its nominal value, this price works out at considerably above a shilling a unit. In 1894 there was a further extension involving the installation in the older station of three new Thomson-Houston eight-pole alternators. These were 120-kilowatt machines running at 2,080 volts (alternating) and 115 periods a second. The engines for these came from Tosi's, at Legnano, and the alternators were belt driven. The Ganz machines make only 43 alternations per second, so that there is no question of paralleling. They are, however, still run for the theatre and its neighbourhood, as if the Thomson-Houston machines are used for that purpose the telephones are so much affected as to render speaking impossible. They, however, appear to do most of the other work, which is principally the supply of theatres and public buildings. The distribution is by overhead wires with porcelain insulators. Guard wires are put in where telephone or telegraph lines are met, and the supply wires are crossed to minimise induction. There are about 20 versts (13 miles) of this air line, and a 50 per cent. increase is contemplated during the year, with, of course, further additions at the generating station. The first transformers used were Ganz ones, giving a supply to consumers at 60 volts. Latterly Thomson-Houston transformers have been adopted supplying the current at 104 and also at 52 volts. Most of the installation and wiring work was done by Olschewicz and Kern, the local representatives of a Vienna firm. It may be mentioned that there are a quantity of arc lamps, some at least of which would appear to be alternating-current ones. With such a mixture of machinery from all parts of Europe, it is not surprising that, in spite of a cheap system of distribution, the tariff should be high. Besides the above two stations, there is another one belonging to the Ministry of Commerce for lighting the harbour. It is supplied with Thomson-Houston International Electric Company's plant, and worked by a company for monthly payments from the Government. The South-West Railway have also a continuous-current generating plant for arc lighting and working cranes at the railway station, and another for arc and incandescent lamps at their works.

Commutator Resistance.—In the spring of 1895 Messrs. Cox and Buck, at Columbia College, in the United States, experimented upon the effect of pressure in reducing contact resistance, and determined the friction losses for different brushes; but making the natural but unwarranted assumption that the resistance was the same whether measured by means of one ampere of current or ten amperes, they entirely neglected the effect of varying current density. The matter has since been further investigated by Messrs. H. J. Edsall and M. C. Rorty, and their results, which formed the subject of a thesis at Cornell University, have been published in the New York *Electrical Engineer.* From this it appears that the apparatus employed consisted of a commutator 5⅝in. in diameter, made up of 64 hard copper segments mounted upon a shaft having a pulley at one end to permit its being driven at any desired speed. To secure electrical connection from brush to brush a strip of sheet copper was wound around one end and carefully soldered to each bar. The results for the different pairs of metallic brushes tested were practically the same, and what variations there were in the runs made with carbon brushes may be laid rather to differences in the condition of the commutator surface than to any difference in the behaviour of the brushes themselves. Two typical series of readings were taken for metallic and carbon brushes. These observations were made upon a metallic leaf brush having a contact area of ·4 square inch, and a carbon brush of the Eickemeyer type having an area of ·2 square inch. The first pair had been in use on a 10-kilowatt bipolar Edison machine and the second upon a 20-light Weston arc machine. The resistance curves were both hyperbolas, the one for the metallic brushes being equilateral. The behaviour of the brushes was best shown, however, by the volt-ampere readings. It was found that the fall of potential is independent of current in the case of the metallic brushes and very nearly so for the carbon brushes. In many cases with metallic brushes the fall of potential was actually greater for very small currents than for the heavier ones. One pair gave 1·6 volts drop for four millionths of an ampere, and only ·7 volt drop for 50 amperes. These rather surprising results are explained on the assumption that the coating which forms upon the commutator surface is practically a non-conductor, and that each different current tears it apart to a different degree. The theory is supported by the behaviour of the resistance when sand-paper is applied to the surface of the commutator. Under such circumstances the voltmeter reading falls practically to zero. With metallic brushes oil produces much the same effect by softening the film. Besides testing the effect of current density upon the contact resistance, runs were made to determine the effect of speed and brush pressure. These seemed to show, as theory would indicate, that mere change in the velocity of rubbing had little or no effect, any increase of resistance with speed being due to increased vibration. The curves for resistance as a function of pressure agreed with those obtained by Messrs. Cox and Buck as to form, which was much like that of the curves for resistance as a function of current. In one case, increasing the pressure of a metallic brush from 1lb. to 6lb. per square inch caused a decrease of only 12 per cent. in the resistance. A pair of carbon brushes showed 28 per cent. decrease in resistance for an increase of pressure from ½lb. to 5½lb. per square inch. It thus appears that brush pressure within the usual working limits is not a very important factor in determining the contact resistance. The results of the experimental work may be summarised as follows: (1) Mere change in the velocity of rubbing has no effect upon contact resistance. (2) Within ordinary working limits increase of brush pressure causes only a slight decrease of resistance. (3) Sand-paper used occasionally upon a commutator will greatly reduce the losses through resistance. (4) Oil used with metallic brushes materially reduces the resistance, especially for small currents. The effect is, however, temporary. (5) Both carbon and metallic brushes tend to reach a limiting condition in which the resistance varies inversely as the current. Although there is nothing particularly unexpected in them, Messrs. Edsall and Rorty's results may be worth the attention of central-station engineers.

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THE PRINCIPLES OF ALTERNATE-CURRENT WORKING.*

BY ALFRED HAY, B.SC.(EDIN.), A.I.E.E.

(Continued from page 68.)

33. We are now in a position to consider the *growth* of a current in an inductive circuit under a steady impressed E.M.F. At any instant, the impressed E.M.F. may be regarded as made up of two components—viz., the component required to maintain the current through the resistance of the circuit, and the component required to balance the counter E.M.F. due to the inductance of the circuit. The first component is simply the product of the current into the resistance; we shall refer to it as the $r\,i$ component of the E.M.F. The second component is measured by the rate of change of the magnetic flux through the circuit. Let us suppose that the inductance of the circuit is L, and that during t seconds the current has changed from i_1 to i_2; the corresponding change in the magnetic flux is $L\,i_2 - L\,i_1 = L\,(i_2 - i_1)$. The mean *rate of change* of the magnetic flux during the same time is $\frac{L(i_2 - i_1)}{t} = L\frac{i_2 - i_1}{t}$; but $\frac{i_2 - i_1}{t}$ gives us the rate of change of the current. Hence rate of change of magnetic flux $=$ L $\times$ rate of change of current.

It is convenient to use a special symbol to denote the rate of change of the current at any instant, and we shall use i' to denote this rate of change.

If we suppose E to denote the E.M.F. applied to the circuit, we have the relation

$$E = r\,i + L\,i' \quad . \quad . \quad . \quad . \quad . \quad (20)$$

This equation will hold good whether E be constant or not. In the present case we suppose E to be constant, but cases will present themselves later on in which E is variable. The equation expresses the fundamental relation between the instantaneous values of the E.M.F. and current in an inductive circuit, and it is very important that the student should have a perfectly clear conception of the physical meaning of the equation. E, i and i' may all change from instant to instant; but *at any one instant* these three quantities are so related as to satisfy equation (20).

34. From equation (20) we have at once

$$i' = \frac{E - r\,i}{L} \quad . \quad . \quad . \quad . \quad . \quad (21)$$

This equation enables us to calculate i' for any given value of i. The relation between these two quantities may be represented by a straight line, as shown in Fig. 25. The greatest rate of change of the current, O A $\left(= \frac{E}{L}\right)$, occurs just at the commencement, when the value of the current is zero. As the current increases, the *rate* at which it does so diminishes, until finally, when the current has reached its steady value, O B $\left(= \frac{E}{r}\right)$, the rate of change becomes nothing.

The student will readily see that the rapidity with which the current rises to any fraction of its steady value will depend on the inclination of the line B A in Fig. 25 to the vertical. The greater this inclination the more rapidly will the current establish itself in the circuit. For if we suppose that the line B A is displaced into the position B A′ so as to become more inclined to B O, then for any given value of the current, such as O P, its *rate of growth* is *increased* from P Q to P Q′; hence, the current will attain its steady value more rapidly in the second case. *Any change in the circuit, therefore, which causes the point A to travel away from the origin will accelerate the rise of current in the circuit.* Now, for a given value of the steady current, $\frac{E}{r}$, the distance of A from the origin may be increased in two ways: first, by *diminishing* L; secondly, by increasing *both* E and r, so that the ratio $\frac{E}{r}$ remains unaltered. In most cases which present themselves in practice it is not practicable to reduce L, but we may in most cases adopt the second expedient by connecting in series with the inductive resistance a large non-inductive one (which adds practically nothing to L but materially increases r), and using a higher E.M.F.

35. Since the rapidity with which a current establishes itself in a circuit depends on the inclination of the line B A, it is convenient to know what the angle O A B is. This angle is generally assigned in terms of its tangent (Art. 2), and the tangent is termed the *time-constant* of the circuit. Now $\tan \text{O A B} = \frac{\text{O B}}{\text{O A}}$—*i.e.*, since O B $= E/r$, and O A $= E/L$, $\tan \text{O A B} = \frac{L}{r}$, so that we have the following alternative definition:

The time-constant of a circuit is the quotient of its inductance by its resistance.

In a circuit having a large time-constant, the current takes a comparatively long time to rise to its steady value; in a circuit whose time-constant is small, it establishes itself very rapidly.

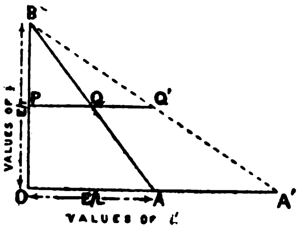

Fig. 25.

The diagram of Fig. 25 may be used for an approximate method of determining the relation between the current and the *time*. The method is based on the assumption that the rate at which the current changes does not vary continuously, but by a series of small steps. The student will best understand the method by studying the following numerical example.

36. Let an E.M.F. of 100 volts be applied to a circuit whose resistance is 10 ohms and inductance ·05 henry. The value of the steady current is $\frac{100}{10} = 10$ amperes. In Fig. 26, let O be taken as origin, and let the vertical axis be the axis of current. We shall suppose that the time is measured along the horizontal axis to the right of the origin. Lay off a length O B $=$ 10 units to represent, on a convenient scale, the 10 amperes. From O lay off O A $= \frac{E}{L} = \frac{100}{\cdot 05} = 2{,}000$, to a convenient scale. The line O A in Fig. 26 corresponds to the line O A in Fig. 25, and it represents the rate at which the current increases just at the commencement. Divide O B into any number of equal parts, say 20; each of these divisions will therefore represent ·5 ampere. The greater we make the number of these divisions the more accurate will be the result. Through the middle point of each division draw a line parallel to O A until it intersects the line A B. The first of these lines determines the mean* rate of variation of the current between the values 0 and ·5 ampere, and we shall suppose that as the current increases from nothing up to ·5 ampere, its rate of change, instead of varying, remains constant and equal to the mean rate of change between those limits. When the current has reached the value ·5, we suppose that its rate of change *suddenly* diminishes, and remains constant while the current increases from ·5 to 1 ampere, and equal to the mean rate of change between those values of the current, and so on. This supposition is equivalent to assuming that the line A B, instead of being a continuous straight line, is a stepped or zig-zag line (shown dotted in Fig. 26).

In order to construct the curve connecting *time* and *current*, we proceed as follows. From the diagram to the left of O B we find that the mean rate of change of the current between 0 and ·5 ampere is 1,950 amperes per second. This means that the current would change by

* Based on a series of evening lectures delivered at the University College, Liverpool.

* Mean, that is to say, with respect to the current, but *not* with respect to the *time*; and that is precisely where the error is introduced in this approximate method.

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one ampere in $\frac{1}{1950}$th, or ·000513, of a second; hence it would increase by ·5 ampere in ·000256 second. We thus get one point on our curve (*a* in Fig. 26). To obtain the next point, we notice that between ·5 ampere and 1 ampere the mean rate of increase of the current is 1,850 amperes per second. Hence the current would increase from ·5 ampere to 1 ampere—*i.e.*, by half an ampere, in $\frac{1}{1,850 \times 2}$ = ·00027 second. Corresponding, therefore, to one ampere we have the time ·000256 + ·00027 = ·000526 second. This gives us another point, *b*, on our curve. By proceeding in this manner we obtain 20 points. According to the supposition which we have made, the growth of the current would be represented by the open polygon formed by joining the points determined as above by straight lines. But we know that the rate of change of the current varies *continuously*, and not by sudden steps. Hence it will be more correct to draw a continuous curve through the points. This curve is shown in Fig. 26.

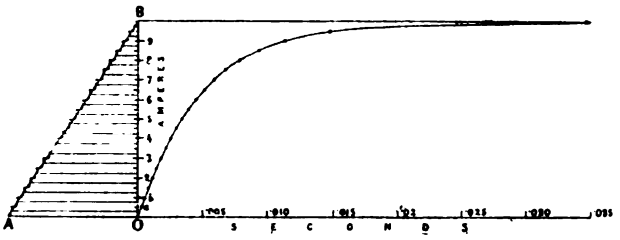

FIG. 26.

The approximate method just explained for drawing the *time-current* curve presents no difficulties, and is capable of furnishing very accurate results. The accuracy may be increased as much as we please by sufficiently increasing the number of points on the curve.

As a matter of fact, the current never reaches the value which we call the "steady value" $\left(\frac{E}{r}\right)$. But after a very short time from the instant of closing the circuit it differs so very little from its steady value, and grows so very slowly, that for all practical purposes it may be regarded as having reached the steady value. Thus, in the example considered, it may be shown that the current falls short of its steady value by only $\frac{1}{100}$th of 1 per cent., ·046 second after closing the circuit.

37. We now pass on to the consideration of an inductive circu t conveying an alternating current which is a simple harmonic function of the time. We shall suppose that the resistance, *r*, and inductance, L, of the circuit are known, and that the maximum value of the current is I. The problem is to find the impressed E.M.F. (Art. 26) in the circuit.

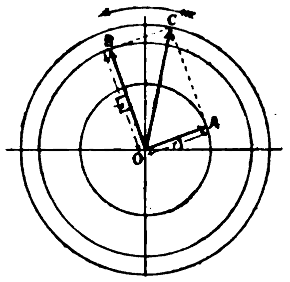

FIG. 27.

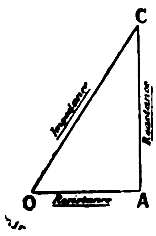

FIG. 28.

At any instant, if *i* denote the current, we have the following relation (Art. 33):

$$\textit{impressed}\ \text{E.M.F.} = r\,i + L\,i',$$

where *i'* stands, as before, for the rate of change of the current at the instant considered. The impressed E.M.F. is thus seen to be made up of two components, the component *r i*, which serves to maintain the current through the *resistance* of the circuit, and the component L *i'*, which balances the E.M.F. called into play by the *inductance* of the circuit. Since we suppose the current to be a simple harmonic function of the time, we may represent its value at any instant (Art. 22) by the projection on the vertical axis of a rotating vector of length I. By taking another rotating vector, O A (Fig. 27), of length *r* I (the vector being in the same phase as that which represents the current) and projecting it on the vertical axis, we obtain an alternating vector whose value at any instant gives us the *r i* component of the impressed E.M.F. Again, since the current is capable of being represented by an alternating vector, its rate of change will be represented by another alternating vector (Art. 22), whose amplitude is *p* I (*p* standing for the angular velocity), and which is $\frac{\pi}{2}$ (or 90deg.) in advance of it as regards phase. The rate of change of the current would therefore be obtained by projecting a rotating vector of length *p* I, and at right angles to O A, on the vertical axis; and the L *i'* component of the E.M.F. (= L × rate of change of current) may be represented by the projection on the vertical axis of a rotating vector O B (Fig. 27) of length L *p* I, which is at right angles to O A. We thus see that the impressed E.M.F. is the sum of two alternating vectors. In order to obtain this sum of the projections of O A and O B, we may first find the resultant O C of the two rotating vectors O A and O B (Art. 18 and Fig. 11). The projection of the rotating vector O C on the vertical axis gives us the instantaneous value of the impressed E.M.F.

38. We have thus shown that if the current in a circuit of constant inductance obeys the simple harmonic law, the impressed E.M.F. is also a simple sine function of the time. In order to find the maximum value O C of this E.M.F., we have merely to notice that since the triangle A O C is right-angled,

$$\begin{aligned} OC &= \sqrt{OA^2 + AC^2}, \\ &= \sqrt{OA^2 + OB^2}, \\ &= \sqrt{r^2 I^2 + L^2 p^2 I^2}, \\ &= I\sqrt{r^2 + L^2 p^2}. \end{aligned}$$

From Fig. 27 we also see that the current is not in phase with the impressed E.M.F., but *lags* behind it by an angle A O C. Now

$$\tan AOC = \frac{AC}{OA} = \frac{LpI}{rI} = \frac{Lp}{r},$$

i.e., the tangent of the angle of lag is equal to the quotient of L*p* by *r*.

If we now suppose that a simple harmonic E.M.F., E sin *pt*, is applied to a circuit of resistance *r*, and inductance L, then it follows from the above that the current is given by

$$i = \frac{E}{\sqrt{r^2 + p^2 L^2}} \cdot \sin(pt - \theta) \quad . \quad . \quad (22)$$

where θ is an angle such that its tangent is equal to $\frac{pL}{r}$.

If we use I to denote the maximum value of the current, then

$$I = \frac{E}{\sqrt{r^2 + p^2 L^2}} \quad . \quad . \quad . \quad . \quad . \quad (23)$$

These equations are of fundamental importance in the theory of alternating currents, and should be committed to memory by the student.

Equation (23) shows that the maximum value of the current is obtained by dividing the maximum value of the E.M.F. by the quantity $\sqrt{r^2 + p^2 L^2}$. This quantity, which is the analogue of resistance in a continuous-current circuit, is termed the *impedance* of the circuit. The quantity *p* L is called the *reactance*. We thus have

$$(\textit{impedance})^2 = (\textit{resistance})^2 + (\textit{reactance})^2;$$

and if θ denote the angle of lag of the current behind the E.M.F., we have

$$\tan\theta = \frac{\textit{reactance}}{\textit{resistance}} \quad . \quad . \quad . \quad . \quad . \quad (24)$$

The diagram (Fig. 28), which a reference to Fig. 27 will at once enable the student to understand, may help to exhibit the important relations between the quantities we have just been considering.

39. The variations of an alternating E.M.F. or current which

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is a simple sine function of the time (Art. 22) are always capable of being represented by a simple sine curve, such as that which is shown in Fig. 12. The time taken by the E.M.F. or current to run through a complete cycle of values is, as has already been explained (Art. 14), termed a *period.* The number of complete periods in one second is termed the *periodicity*. The symbol ~, introduced by Mr. Mordey, is used to denote the periodicity. Thus 100 ~ per second means "100 complete periods in every second." If the periodicity n is given, then, remembering that $p = 2\pi n$ (Art. 17), we can at once calculate the reactance, and hence also the impedance, for a circuit whose resistance and inductance are known. The periodicities commonly used in this country vary from 40 to 100 ~ per second.

40. We shall now apply the results established above to a numerical example.

Let an alternating simple harmonic E.M.F. whose maximum value is 100 volts be applied to an inductive circuit whose resistance is 18·2 ohms, and inductance ·0796 henry. The periodicity we shall suppose to be 100 ~ per second. In order to find the maximum value of the current we must calculate the impedance Now, $p = 2\pi \times 100 = 628{\cdot}32$, so that

$$\text{reactance} = p\,L = 628{\cdot}32 \times {\cdot}0796 = 50.$$

Hence

$$\text{impedance} = \sqrt{r^2 + p^2 L^2} = \sqrt{18{\cdot}2^2 + 50^2} = 53{\cdot}21.$$

Therefore,

$$\text{maximum value of current} = \frac{\text{maximum value of E.M.F.}}{\text{impedance}} = \frac{100}{53{\cdot}21} = 1{\cdot}88 \text{ amperes.}$$

Next, if θ denote the angle of lag,

$$\tan\theta = \frac{\text{reactance}}{\text{resistance}} = \frac{50}{18{\cdot}2} = 2{\cdot}747.$$

In order to determine θ, we may, as in Fig. 28, construct a right-angled triangle O A C whose sides O A and A C are equal to the resistance and reactance respectively. The angle A O C will then be the angle of lag. By measuring this angle with the protractor the student will find that it is about 70deg.

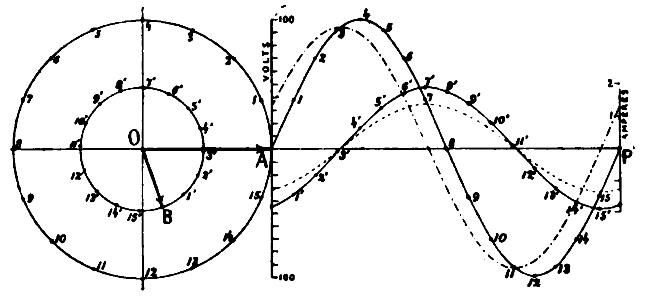

Fig. 29.

To construct the E.M.F. and current curves we may adopt the method explained in Art. 20 and illustrated by Fig. 12. Take one rotating vector, O A (Fig. 29), of length = 100 (to a convenient scale), and another, O B, of length = 1·88, inclined to the first at an angle of 70deg. As the two vectors rotate with the same angular velocity, p (= 628·32 radians per second), round O, the projection of O A on the vertical axis gives the instantaneous value of the E.M.F., while that of O B gives the instantaneous value of the current. By dividing the circumferences of the two circles along which the extremities of the rotating vectors travel into the same number of equal parts, and proceeding as explained in Art. 20, we derive the E.M.F. and current curves shown to the right of Fig. 29. The points of division 1, 2, 3 . . ., and 1′, 2′, 3′ . . ., are so related that they correspond to simultaneous positions of the two vectors. The distance A P corresponds to a period—*i.e.*, to ·01 second.

41. The impressed E.M.F., as we have seen, may be regarded as made up of two components, the one to overcome the resistance of the circuit (the $r\,i$ component), the other to balance the effect due to the induced E.M.F. We can readily analyse the impressed E.M.F. curve shown in Fig. 29 into these two components. By taking a number of points on the current curves, and multiplying the corresponding ordinates by 18·2 (the resistance of the circuit), we obtain the $r\,i$ component of the E.M.F., shown dotted in Fig. 29. By subtracting the ordinates of the curve so obtained from the impressed E.M.F. curve, we obtain another sine curve, which gives us the component required to balance the E.M.F. due to inductance. This is shown chain-dotted in the figure. These curves might also have been obtained directly by projecting two rotating vectors, the one of length r I and in phase with O B, the other of length L p I and at right angles to O B (*c.f.* Fig. 27). The student will notice that the L i' component of the impressed E.M.F. passes through its zero value when the current reaches its maximum value—*i.e.*, becomes stationary for the moment, so that its rate of change is nothing—and *vice versâ.* This will also be at once evident by referring to Fig. 27.

42. The quantity, then, which determines the amplitude of the current—*i.e.*, its maximum value, Art. 14—in an inductive circuit is not merely the *resistance* of the circuit, but its *impedance.* If the periodicity is low then the resistance of the circuit is more important than the reactance, so that for *very slow* alternations of the E.M.F. the current will depend mainly on the *resistance* of the circuit. As the periodicity increases, however, the *reactance* becomes more and more important, and for *extremely rapid* alternations of the E.M.F. the impedance will depend almost entirely on the *reactance*, the resistance becoming practically insignificant.

In order to exhibit this change of impedance with the periodicity the numerical values of the reactance and impedance corresponding to various periodicities for the circuit already considered have been plotted in Fig. 30. The horizontal straight line above the axis of periodicity, and at a distance of 18·2 from it, represents the *resistance* of the circuit, which is assumed to be independent of the periodicity.* The sloping straight line represents the *reactance*, which increases at a constant rate with the periodicity. Finally, the uppermost curved line gives the values of the *impedance*, calculated from the formula $\sqrt{r^2 + p^2 L^2}$. It will be noticed that for *very low* values of the periodicity, the impedance line is almost coincident

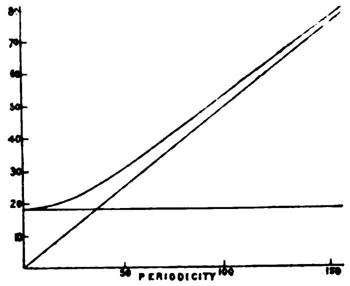

Fig. 30.

with the line of resistance, while for *very high* values it tends more and more towards coincidence with the line of reactance.

We have hitherto supposed that we are dealing with a circuit for which L is a constant. In many important practical cases, L is a variable quantity; this is always the case for any coil containing a core of magnetic material. The simple relations which we have established between the E.M.F. and current will then no longer hold. But the general principles involved will be the same. Thus, the fundamental equation connecting impressed E.M.F. and current will assume the form

impressed E.M.F. = $r\,i$ + *rate of change of magnetic flux,*

instead of the more special and simpler form of Art. 33. The general conclusions regarding the effects of resistance, reactance, and impedance which we have deduced for a circuit of constant permeability will also hold for a circuit containing iron.

(To be continued.)

* As a matter of fact, the resistance is *not* independent of the periodicity, owing to the crowding of the current towards the outer portions of the conductor. This effect will be discussed later.

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RAILWAY BLOCK SIGNALLING.

BY J. PIGG.

(Continued from page 69.)

The form of indicator connected in the continuation of the "down" line wire between E and B, at C and D, is shown by Fig. 16. The dials are divided and lettered in the same way as those of the block instruments, but the signalmen at C and D have no control over the indicators.

FIG. 16.—Subsidiary Block Indicator.

They are merely used to indicate the condition of the line between E and B in order that the signalmen at C and D may not undertake any operations involving the fouling of

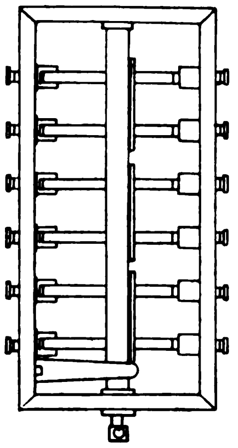


FIG. 17.—Switch (Plan). Instruments in Circuit.

the "down" line under such conditions as, by an error of judgment or failure of apparatus, would lead to an accident.

closing certain cabins at stated periods, and working the traffic between the cabins on each side as a block section. Thus, of three successive cabins, A, B, and C, B may be closed from 10 p.m. to 6 a.m., say, and the section between these times would be from A to C. The alteration in the lengths of the section would be effected by a switch placed in B, which would be turned to the appropriate position

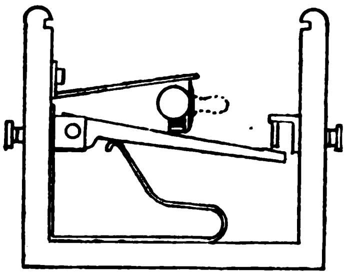
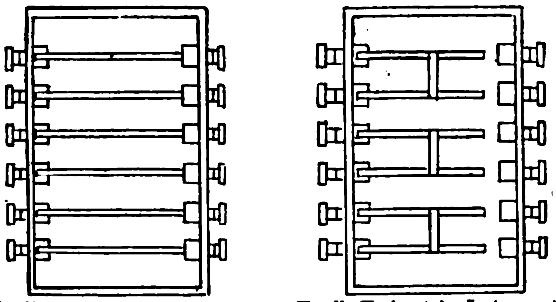


FIG. 18.—Switch (End View). Instruments out of Circuit.

by the signalman before leaving, and after giving notice to A and C by the signals provided in the code for such purpose.

The form of switch generally used for switching three-wire circuits is shown by Figs. 17 and 18, and the diagrams (Figs. 19 and 20) show the connections in the switch for the two positions it can occupy.

FIGS. 19 AND 20.—Three-Wire Block Switch.



Handle Vertical. Instruments in Circuit. Handle Horizontal. Instruments out of Circuit.

The connections for a complete block cabin of the simple character indicated by Fig. 9 are given, diagrammatically,

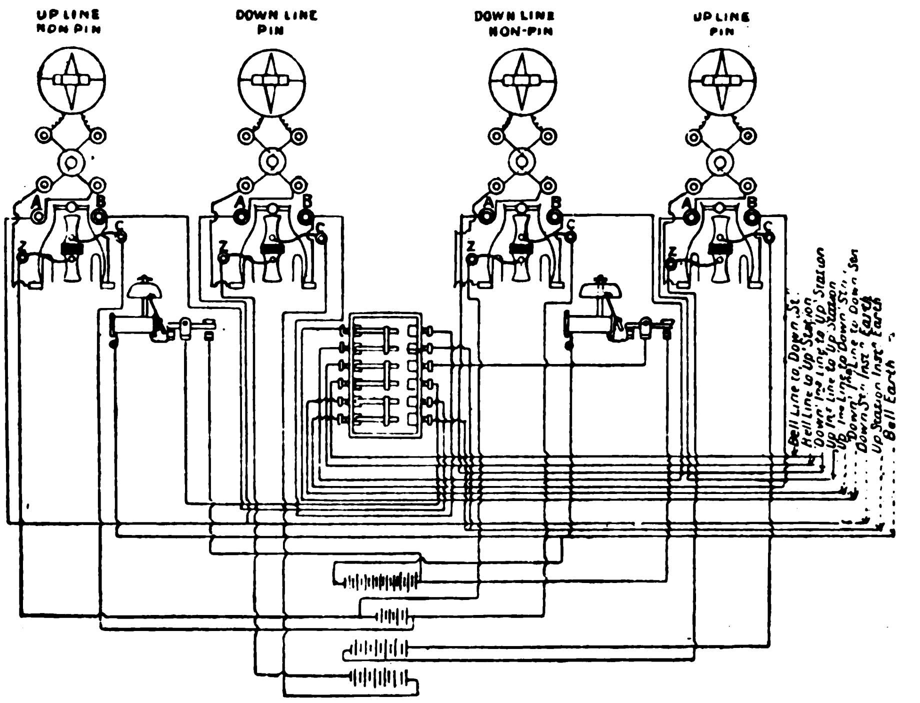


FIG. 21.—Diagram of Connections.

SWITCHING BLOCK APPARATUS.

It frequently happens that a block cabin is not required to be open during the whole 24 hours, owing to the traffic being less than ordinary during part of the time. Advantage is taken of this, wherever possible, to economise labour by

in Fig. 21, in which the switch is shown with the connections arranged as when the cabin is closed. It will be noticed that the two indicating instruments working to the "up" station are in circuit, and will, therefore, reproduce all signals sent from the cabins on either side. The object

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of this arrangement is to enable the signalman to ascertain, when opening out the cabin for ordinary working, whether any trains are in the section he is about to divide. If the block indicators show that trains are in the section, or that the preliminary signals for trains entering the section have been acknowledged, the signalman at the cabin which is being opened pins the instruments at that place appropriately. If he gets the "Train passing out of section" signal from the advance cabin, he also gives that signal to the cabin in the rear, and afterwards takes all

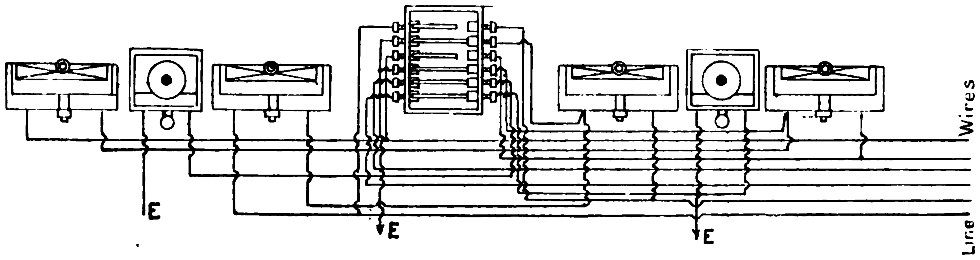

FIG. 22.—Instruments in Circuit—Cabin Open.

succeeding signals himself. The code provides signals which indicate to the cabins on either side when an intermediate cabin is being closed or opened, so that the signalmen at the ends of the long section know when they are working to each other, and when to the intermediate cabin.

Another method of switching instruments in and out of circuit, with a switch of similar construction, is shown in the diagrams Nos. 22, 23, and 24. In Fig. 22 all instruments are earthed at that cabin which is open. In Fig. 24 all instruments are cut out of circuit, and the cabin is closed.

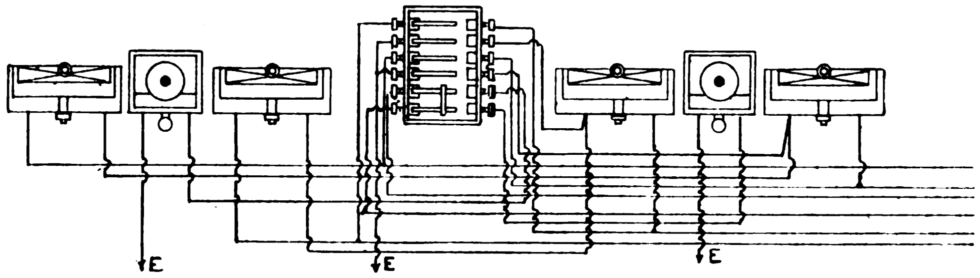

FIG. 23.—Intermediate Position—Cabin about to be Opened.

In Fig. 23 the block indicators are in circuit, but are working through between the cabins on either side. With the switch in the latter position the signalman is able to ascertain whether there are any trains in the section he is about to divide, in order that he may arrange to exhibit the proper indications on the block instruments at the two cabins he will work to.

The essential difference between the two methods of switching is that with the switch shown in Fig. 21, one instrument for each line is constantly in circuit; with the

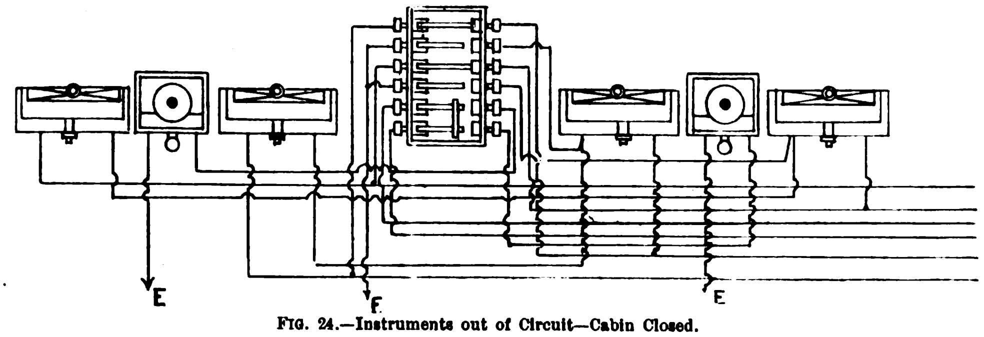

FIG. 24.—Instruments out of Circuit—Cabin Closed.

switch shown by Figs. 22, 23, and 24, all instruments are cut out of circuit until such time as they are required to be brought into operation. It will be noticed that with either form of switch no alteration of battery power is made at the cabins which are working through another which is closed. The batteries are always installed with a margin sufficient for the maximum distance they have to work through.

GATE CROSSINGS.

It frequently happens that a highway crossing is situated between two block cabins. Such crossings are, of course, provided with a gatekeeper, but if the crossing is situated on a sharp curve, or during foggy weather, the gatekeeper has some difficulty in assuring himself that no danger exists in opening the gates for vehicles, foot-passengers, or, worst of all, cattle passing along the road. Matters were improved by providing the gatekeeper with an intermediate bell connected in the block bell circuit, which reproduced all the bell signals exchanged between the cabins on each side of the crossing. This method was imperfect, in that the gatekeeper had to distinguish the different classes of signals from each other, to rely on his memory after the signals had passed, and was unable to distinguish between signals for "up" and "down" trains.

The apparatus now provided is shown by Fig. 25. The small needle indicators are inserted in the "up" and "down" block indicator circuits, and the bell is inserted in the block bell circuit as before. The gatekeeper has no control over the instruments, and is not called upon to do any work in connection with them, but by the aid of the indicators he is able to see at any time whether a train is approaching from either direction, and from the character of the indication, "Train on line" or "Line clear," is able to judge its approximate distance.

SIGNAL REPEATERS.

When signals are not visible from the cabin from which they are worked, some means of indicating the position of the arm becomes necessary. At one time it was customary to fix a small subsidiary signal in a position where the signalman could see it, and arrange it to be worked from the same wire as the signal it was intended to represent. Such mechanical repetition had many defects and was unreliable, and electrical methods of repeating signals were early brought into use.

The forms that signal repeaters have taken at various times and in various hands have been numerous. Some have been miniatures of the signal and arm, others have the indications lettered on dials, and the position of the arm is shown by relative positions of the pointer, or the indications exhibited. Some repeaters show "off" and

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"on" only. Others have been made to show "on," "caution," and "off," whilst still others show "on," "out of order," and "off." Some forms of repeaters require two wires, but the majority only require one; some forms require continuous currents to maintain the "on" positions, others to maintain the "off" position, whilst still others require continuous currents for both "on" and "off." The disc indicator, shown in Fig. 26, requires continuous currents for both "on" and "off"; the semaphore form shown in the same figure requires a continuous current to maintain the "on" position, whilst the needle form of indicator shown by Fig. 28 requires continuous currents for the "off" and "out of order" positions.

The construction of the contact-boxes at the signal for providing the necessary indications is naturally governed by the character of the indications decided upon as desirable. An earlier form of contact-box and the method of fixing is shown in Fig. 27, where the movement is obtained from the rod at a point between the counterweight and the arm. In

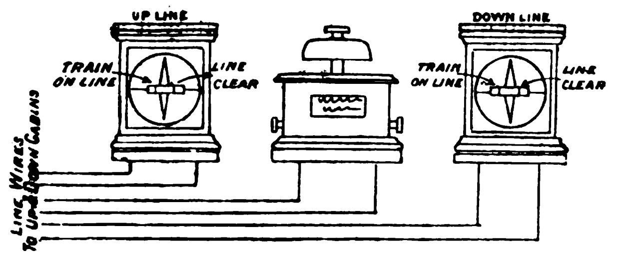


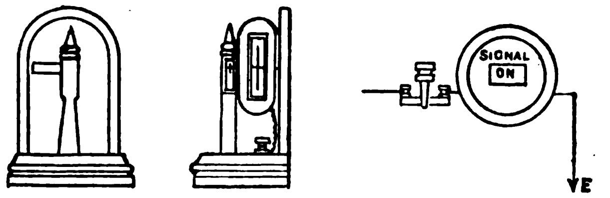
FIG. 25.—Gate Crossing Equipment.

this method the indicator shows two positions only—"on" and "off," the "on" position being the normal indication when no current was passing, and the "off" being maintained by a continuous current.

Consideration of the conditions of working shows that such an arrangement lacks the reliability so important a piece of apparatus should have. In the first place, the point indicated is not that of the arm itself; in the second place, the apparatus is self-testing in one position only. If the rod working the signal arm broke between the contact-box and the arm, or if the key fixing the arm to the spindle slipped out, the arm would indicate "off" whilst the electrical repeater would be showing "on."

Further consideration shows that the relative positions of the signal lever, signal arm, and electrical repeater are of great importance, and that there exists a great necessity for the repeating apparatus being self-testing in the "on" position. If the signal arm is "on" when the signalman expects it is "off" no accident is likely to occur, and slight delay to traffic is the only probable consequence. If, however, the signal is "off" when the signalman expects that it is "on" the consequences may be very different, since it

FIG. 26.



Semaphore Distant Indicator. Disc Indicator with Plug Switch

is the signal arm which ultimately controls the passage of traffic, and all other apparatus, mechanical or electrical, are merely accessories used to ensure the exhibition of the proper outside signals for the time being.

The forms of contact-box shown by Figs. 28 and 29 are fixed concentrically with the spindle of the signal arm, and obtain the motion from the movement of the spindle. They are used in connection with the needle form of repeater shown in Fig. 29. With this form of repeater three positions are shown—"on," "out of order," and "off"; and Fig. 29 is drawn to show the "out of order" position. This indication, as will be seen, is an intermediate one between the "on" and "off" positions of the arm, and must be passed over each time the arm passes from "on" to "off," and *vice versâ*. The chief use of this indication is to show that the signal arm is *fully* "on" or "off." An "out of order" signal would be shown on the electrical repeater instead of an "off" signal in one case, or an "on" signal in another case, if the wire working the signal has become slack or tight from expansion or contraction respectively, and such an indication would be interpreted by the signalman as indicative of the necessity for regulating the wire working the mechanical signal.

It will be noticed that the movement indicated is not that of the arm but that of the spindle; and that the

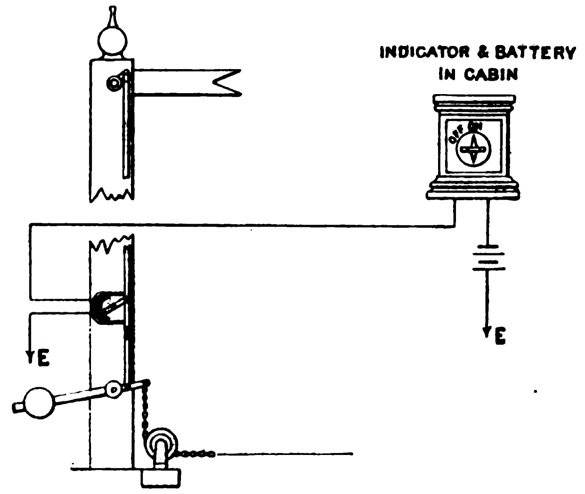


FIG. 27.

removal of the key fastening the arm to the spindle would allow the signal arm to fall, without effecting a corresponding change of position of the electrical repeater. It is true that the position the arm would take up under these circumstances would, if noticed by a driver, be regarded with suspicion, but it should not be forgotten that it is the signalman for whom the repeater is provided, and he would have no notification of the position of the arm being other than that corresponding to the position of the lever working it.

The "out of order" indication of the form of electrical repeater shown in Fig. 29 is of some interest when its

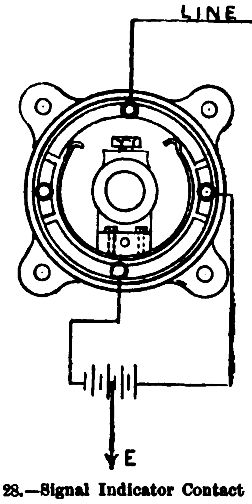


FIG. 28.—Signal Indicator Contact Maker.

significance is understood, and the limitations imposed by the form of instrument and the method of using are considered. As has been stated, the "out of order" indicates a discrepancy between the relative positions of the signal arm and the lever, and so far it is a true "out of order" indication. Whilst this is so, it will be observed that owing to the repeating apparatus not being self-testing in the "on" position, conditions may easily arise where the indication of the electrical repeater may differ from the actual position of the arm, and the latter differ from the position of the lever. Further, a defect in the repeating apparatus, if it occurs when the signal is "on," affords no indication of its existence to the signalman.

To the writer it seems unsound to treat the signal and the repeating apparatus as different pieces of apparatus. Rather, it seems, that they should be considered as one,

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and the "out of order" signal should be such as not only indicates a discrepancy between the positions of the arm and lever, but also a defect in the repeating apparatus. In short, an efficient repeating apparatus should do, for a signal which is out of sight, all that a signalman can do for himself in connection with a signal within sight.

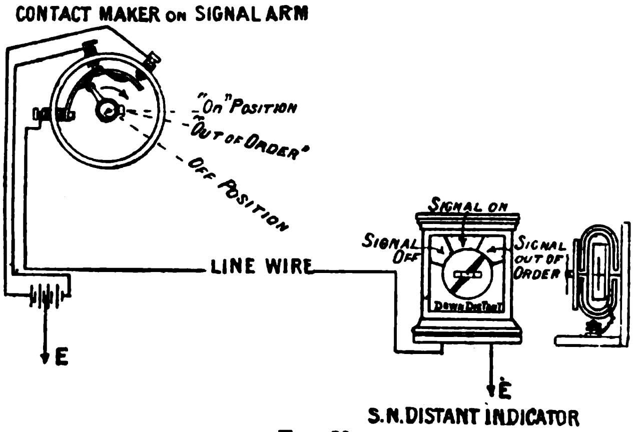


Fig. 29.

Another form of contact-maker, and the method of attaching to the signal, is shown by Fig. 30. It is used in conjunction with the disc indicator shown in Fig. 26. The "on" and "off" positions are both maintained by continuous currents: if from any cause the circuits are broken, the indicator takes up an intermediate position as shown in Fig. 30. This form would appear to possess considerable advantages over the forms shown by Figs. 27, 28, and 29 in that the movement indicated is that of the arm itself, and the apparatus is self-testing in any position. The intermediate position shown by Fig. 30 is a true "out of order" signal and is shown not only when the arm occupies a different position to that of the lever, but also when a defect occurs in the electrical repeating apparatus. A

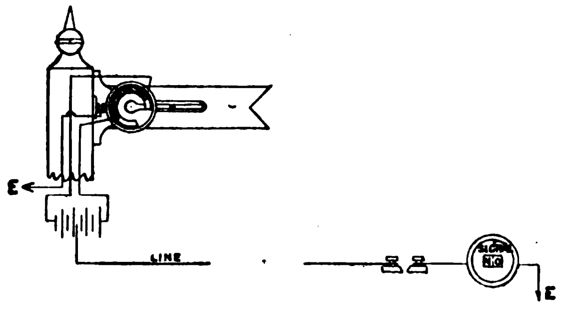


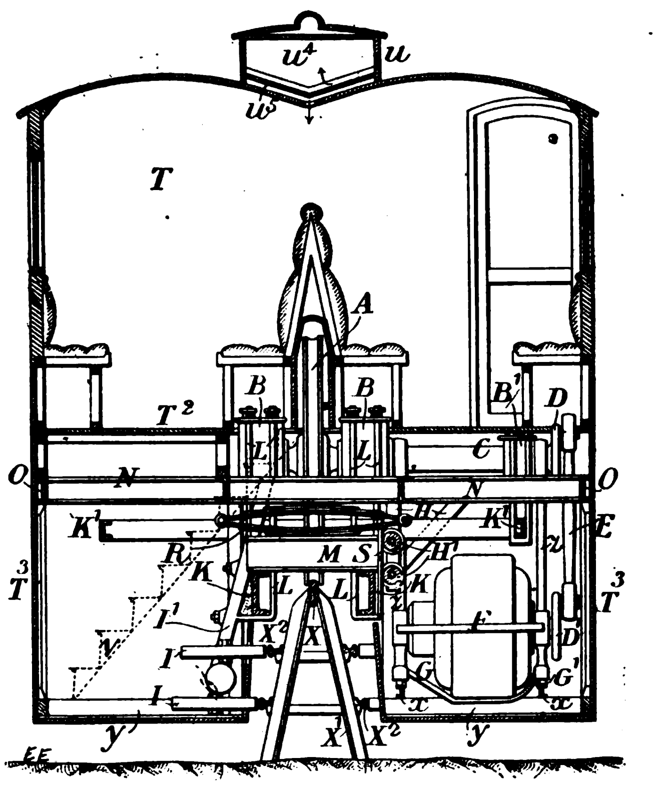
Fig. 30.

small peg switch is provided by which the circuit may be disconnected during such times as the signal is not being used, in order to prevent the batteries being run down unnecessarily. As the Board of Trade inspectors require signal indicators to be fixed in plain sight and immediately opposite the lever working the signal, there is not much danger of the absence of the peg being unnoticed when the apparatus is being brought into use. At the same time, combinations of circumstances may arise in which the absence of the usual indication would be undesirable.

(*To be continued.*)

LIGHTNING EXPRESS RAILWAY TRAINS.

On Monday last we inspected a model of Mr. F. B. Behr's lightning express trains by invitation. The method devised by the inventor for the attainment of average speeds of from 100 to 150 miles per hour has been before the public for some years. The feature of the departure from existing practice is that of supporting the weight of the train on one rail only. The simplicity of the track is not in any way increased by the reduction of the number of rails from two to one. It appears from our talk with Mr. Behr that four guide rails become necessary, and that the central weight-bearing rail has to be supported at from 39in. to 60in. above the surface of the ground. The general arrangement of the track is seen in the illustration, which also shows an end section of the car. Each carriage will have its own driving power, so that there will be little stress in the couplings. We had a long and most interesting conversation with Mr. Behr on his details of design, and were pleased to hear that he is constructing a trial track at Brussels. It will form one of the attractions of the 1897 exhibition to be held at that city. The line at Brussels will be about 3½ miles long, and will be practically oval in form. The end curves are, however, arcs of circles. We understand that a speed of 95 miles per hour has been guaranteed on these curves, which have a radius of only some 550 yards. From a pamphlet given us, dated 1893, we find the mechanical stress has been well considered, but we fail at present to see that the scheme has exceptional advantages over the ordinary railway. The Brussels line will, however, give a good trial to the proposed arrangement, and if the speed guaranteed can be maintained with safety it must be quite



Section of Carriage and Track of High-Speed Train.

safe on a straight track. The electrical details of this trial line have been placed in the able hands of T. Parker, Esq., of Wolverhampton, so that nothing in that section of the problem will suffer from want of experience. The mechanical stress when running at 95 miles per hour on the above-mentioned curves reaches an alarming amount. Thus, the centrifugal force tending to throw the cars outwards reaches the respectable figure of 20 tons. This stress is to be taken by the guide wheels on the inside. Then we are assured that the guide wheels on each side of the car are so linked together that the pressure on both sides is bound to be equal. If this should really be so, we wonder what driving power will be required on the curve, as it would appear from the above that the guide wheels will seize the rails.

The following are the improvements claimed by Mr. Behr, the mention of which may be of interest to those of our readers not already acquainted with this invention.

Firstly, the carriages have a considerable total length to enable them to pass readily round sharp curves. This is effected by constructing the carriage in two or more separate parts, joined together by a pivot or universal joint. A flexible enclosure covers a platform between the two adjoining parts, from which access is gained to each part. Each half is supported on the rail by two driving wheels, placed as close as practicable together so as to obtain a comparatively small fixed wheel base.

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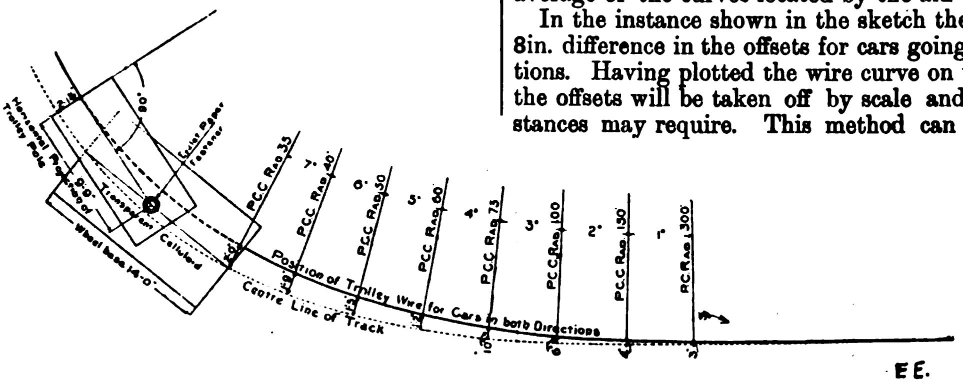
Secondly, the centre of gravity of the carriage is kept below the level of the line of rail, even when the entire floor for the passengers is raised above the line of rail. This is effected by placing the motors that propel the carriage at the bottoms of the two lower parts of the vehicle, and so arranging them that although they partake of the vertical motion of the carriage body upon its springs, the distance between their driving shafts and the driving wheel axles, by which they are connected by driving gear, shall always remain constant.



Method of Locating Trolley Wire on Spiral Curves.

Thirdly, the carriage body, though having a vertical motion on springs, is so guided that it cannot move laterally; this is effected by constructing the framing carrying the driving wheels and bogie entirely separate from the framing of the carriage body and guiding the former in a vertical position by means of guide wheels running on lateral guide rails on the line rail supports. The framing of the carriage body, which rests upon the wheel framing with springs, is prevented from lateral motion by providing the wheel frame with vertical rails, against which bear rollers attached to the carriage body.

Fourthly, two guide rails are provided, situated one above the other, against which bear two corresponding guide wheels on each side of the wheel frame of the carriage. In order to ensure that both wheels shall always be kept automatically in contact with both the guide rails so as to distribute the lateral strains on the carriage uniformly over both, the guide wheels are mounted upon vertical arms projecting upward and downward from a horizontal axis that can turn in bearing in brackets on the wheel frame.

Whatever be the result of the Brussels trial line, we consider that Mr. Behr deserves credit for the energy he has thrown into the subject, and for the fact that the money to equip this line is provided privately by himself and a few friends.

THE CORRECT POSITION OF A TROLLEY WIRE OVER CURVES.

Mr. C. A. Alden, writing to the *Street Railway Journal*, describes the following method of graphically ascertaining the correct position a trolley wire should take over a curve on an electric railway. Mr. Alden says that the proper location can be easily found by the use of a template of the essential elements of the problem—*i.e.*, the wheel base and the horizontal projection of the trolley pole.

Having a plan of the curve for which the location of trolley wire is desired to a scale of 5ft. to the inch, or larger, take a piece of thin transparent celluloid and cut it to the length of the wheel base (on the same scale as the plan) and mark with a sharp point a line for the centre line of the car and mark the centre of the wheel base. Then cut another piece a little longer than the horizontal projection of the trolley pole. Mark a line on this at right angles to one end and mark the length of the horizontal projection of the trolley pole from this end. Then join the two pieces at the centre of the wheel base and centre of the trolley base by an eyelet paper-binder, loosely enough so that they may turn with some little friction.

Then, placing the template upon the plan of the curve so that the wheel base coincides with the centre line of the curve, and swinging the "trolley pole" until the square end is radial to the track curve, we can mark a point which will be approximately on the wire curve. Carrying this process through the spiral to the point where the offset becomes constant, we next sketch in the approximate location through the points just found. Going over this again, and making the "trolley pole" square with radial lines from this approximate location instead of those of the track curve, we can lay down the final location of the wire for cars to run in one direction. If cars are to run in both directions the location should be found by taking an average of the curves located by the aid of the template.

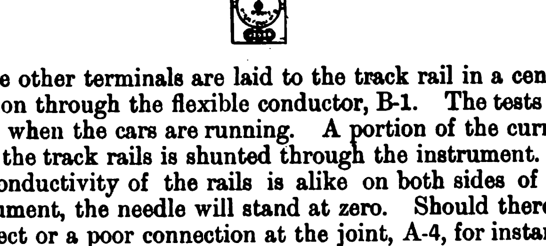
In the instance shown in the sketch there is from 6in. to 8in. difference in the offsets for cars going in opposite directions. Having plotted the wire curve on the plan, of course the offsets will be taken off by scale and used as circumstances may require. This method can also be used for locating frogs over complicated switchwork when the curves are compounded, in finding the proper position for the trolley wire in a carhouse door, and in other ways which will suggest themselves to the constructing engineer. The time taken for the operation, having the plan and template in hand, should be trivial. If the outer rail of the curve is elevated the trolley wire should be set in towards the centre of the curve an additional amount equal to

$$\frac{\text{Elevation} \times \text{height of trolley wire above rail}}{\text{gauge}}.$$

HENRY'S RESISTANCE DETECTOR FOR RAIL JOINTS.*

The object of this instrument, invented by Mr. John C. Henry, of Denver, Col., is to make an examination as to the conductivity of the joints connecting the track rails. Heretofore the only method of testing the bonds when any trouble occurred was to open the pavement and replace all the bonds, both good and bad.

By the Henry method an electrician, with the assistance of a couple of boys, is enabled to examine the condition of the joints on several miles of road in a day, and can mark the defective ones for repairs. The theory on which the method works is as follows: The instrument, which is called a "resistance detector," is a specially designed differential ammeter, which is so arranged that opposing magnet coils influence the needle. Those coils are connected to the portable flexible conductors, B and B-2.



The other terminals are laid to the track rail in a central position through the flexible conductor, B-1. The tests are made when the cars are running. A portion of the current from the track rails is shunted through the instrument. If the conductivity of the rails is alike on both sides of the instrument, the needle will stand at zero. Should there be a defect or a poor connection at the joint, A-4, for instance, more current will flow around that joint through the right-hand coil of the instrument and the lead, B-2. In consequence, the instrument becomes unbalanced, and the pointer shows the direction of the cause. By closing in with the conductors, B and B-1, the bad joint can be located and marked for repairs.

* From the *Electrical Engineer* (New York).

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TO CORRESPONDENTS.

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CABLES.

Many years ago an educational reformer remarked that reforms were obtained, not by once showing existing methods of procedure wrong, but by continuously, and over a considerable period of time, pointing out their defects. It is the constant dropping of water that wears away the stone; hence with such views and axioms before us we have no hesitation in again and again calling attention to points which, under certain circumstances, are apt to be overlooked. Initial expense *v.* maintenance might well be a text fixed above the entrance doors of all central stations. From all sides we are constantly hearing strong criticisms about stations designed evidently without due consideration of ultimate requirements. At various times specific points have been discussed in these columns, but there is one which has not had its due share of discussion. We refer to cables. In many instances the cables originally laid have had to be replaced, in some cases more than once. It would be an interesting paper that dealt completely with this subject, giving the exact history of half a dozen well-known undertakings. The explanations added to estimated costs and balance-sheets frequently contain paragraphs pointing out that a large initial expenditure has been incurred in laying mains which in the early days of the undertaking will not be fully utilised, but with increased demand for current will be brought into full operation. That is all very well, and no engineer objects to looking ahead in that manner; but objection is taken to the false economy of putting down mains that will be utilised to their total capacity almost before the end of the first year's working of the station. Here, again, however, we may admit that in many instances the load does increase far more rapidly than could well be anticipated, and the engineer may, under these circumstances, be acquitted from blame. The worst case of all is to be found in the fact that "faulty" cables are far too frequently found in central-station work. Now, the engineer's duty, if he considers the maintenance cost, is to be on the safe side with his mains. There ought not to be a quarter of the faults that are daily found. Each fault is a source of various troubles, all more or less costly, the least of which is perhaps its repair. These things are all well known, and need only to be stated to be accepted as correct. The moral, however, is more to our purpose. The cost of renewals is usually added to capital account; the cost of repairs, the cost of leakage, and other evils, appear among current expenses. A large part, if not the whole, of these costs might be avoided by proper mains in the first instance. Cheap and nasty is as appropriate to mains as to any other article of commerce. We will not go so far as to say that faults can always be avoided; they cannot, but a large percentage of the usual faults as now found in mains can be avoided. The additional initial cost would be a small addition to capital account compared with the cost of renewals, and when within the short period of three or four years renewals have to be made two or three times, the capital

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account ultimately stands at a much higher amount than it ought to do. To earn dividends upon too great capital means increasing disproportionately the responsibilities of the station officials, dividends are decreased, and price per unit to customers increased, thus doing damage all round. It has not been a general maxim among all manufacturers of mains that insulation for electric light and power purposes is as important a factor in good work as is insulation for submarine cable work. Firms of repute, however, have from the very first understood the importance of the subject; but, as an engineer said the other day, the danger is from mains and wires made by nobody—that is, are not sold as manufactured by a firm of repute. It is not often that mains by unknown makers are used in central-station work, but they have been largely used in private work; hence the necessity of calling attention to the danger of using them. Mr. Nobody, in the case of fault, is the responsible party, and as he cannot easily be found the course usually taken is to replace the main and make as little fuss over the matter as possible.

Another question which will have to be considered is the deterioration of mains. They are not going to last for ever, but as yet we have absolutely no exact knowledge as to the life of a properly constructed, insulated, and laid main. As usual, we shall no doubt be twitted about writing generalities rather than criticising specific instances, but we can assure our readers that under existing legal disabilities specialisation in these matters is impossible. Indeed our purpose will be served if the younger generation of engineers are rendered a little more cautious in writing their specifications, and prefer the safe rather than the cheap, and think more of the future than the present.

CHOKING COILS AND ARC LAMPS.

Our special correspondent's letter in our last issue has had most beneficial results. The editor of our contemporary, after carefully looking up the theory of the matter, now assures his readers that the usual method of obtaining constant current is to vary the voltage of the circuit according to the number of lamps. Mr. Feldmann has, however, the same editor's kind permission to say that the system with choking coils in parallel with arc lamps keeps the voltage constant within limits. The editor admits that this is quite possible, but to support the last part of the letter in question he states that he previously had doubted the veracity of our special correspondent. The interview in question has thus evidently repaid him for reading it a second time.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

ELECTRICAL SANITATION.

SIR,—It having come to our knowledge that certain works have been established, advertisements published, and circulars issued by certain persons calling themselves the British Electrozone Corporation, Limited, with reference to the manufacture and sale by them of a disinfectant called "Electrozone" and "Meditrina," and also with reference to a process which they claim for treating sewage by means of electrolysis, we take this early opportunity of informing you that we have commenced proceedings against the British Electrozone Corporation, Limited, for an injunction to restrain them from infringing our letters patent Nos. 5,393 of 1887 and 15,384 of 1887, and for damages, it being alleged by us that the process adopted by the defendants is an infringement of the process protected by our patents.

We may say that our process has been for some time past successfully adopted by the War Office at Netley Hospital, by the Corporation of Ipswich, the marine hospital at Rio de Janeiro, Brazil, by a French steamship company on one of their American line of steamers (the ss. "Paraquay"), and is under consideration by numerous other public bodies both in this country and abroad.

Our process is economical, effective, and continuous, and can be used either in the place of or in conjunction with existing systems of drainage, whether in towns, public or private buildings, ships, or any place where sewage or sewage effluent is required to be treated without interference with existing drains or pipes or cisterns, and it not only removes all noxious smell, but is a complete germicide.

We are also manufacturing the solution in portable form, and shall be pleased to forward samples, with any further particulars or information, on application.—Yours, etc.,

E. HERMITE.
E. J. PATERSON.
C. F. COOPER.

3, Princes-mansions, S.W.,
June 30, 1896.

AN INTERNATIONAL (?) CONGRESS.

SIR,—Noticing some paragraphs in the technical Press announcing how certain American electricians of high standing were coming over as delegates to an international electrical congress to be held at Geneva in August next, it occurred to me to enquire what questions were to be discussed at this congress, and who were the British delegates. As a member of the Electrical Standards' Committee of the British Association, I had heard nothing of any proposals, nor had I any recollection of any delegates being sent by the Institution of Electrical Engineers.

The replies to my queries only add to my bewilderment. Nothing has been heard of the proposed international congress at the Foreign Office, at the Board of Trade, or at the General Post Office. Mr. Preece, who has attended every electrical congress hitherto, has heard nothing of this affair at Geneva, except what he has gathered from the recent Press paragraphs, has had no invitation to attend, and is not going. No invitations to send delegates have been received by the Royal Society, by the British Association, by the Physical Society, or by the Institution of Electrical Engineers. Nothing is known of the proposal by any of these bodies, except the Institution of Electrical Engineers, the president of which in February last received from Messrs. Palaz and Cuénod, of Geneva, a circular announcing that an electrical exhibition would be held in that city, and asking the "patronage" of the Institution for a congress of electricians to be held in August. The Council of the Institution on March 26 instructed the secretary to reply that they had pleasure in granting this request to enrol the Institution as a patron. At the same time, a corrected list of members of the Institution was forwarded to Geneva. Nothing more was heard until June 19, when a circular, also signed by Messrs. Palaz and Cuénod, dated June 17, and addressed to the *Journal* of the Institution of Electrical Engineers, London, was received by Messrs. E. and F. N. Spon. In that circular the following paragraph occurs: "Invitations to take part in the forthcoming congress [on August 4] are now being sent out, and with the object of making it more generally known we take the liberty of asking you to be kind enough to make this known in your next issue." But the invitations appear never to have been sent! So far as I am able to ascertain, not one single English electrician has yet been invited to attend, nor have any of the scientific societies received any subsequent communication.

It is now July 24; the "International Congress" is to meet on August 4. Even if in the interim invitations

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should be received, it will be impossible for the societies to appoint delegates.

Any decisions of a congress so composed can carry little weight internationally. Assuredly England is justified in disclaiming beforehand all responsibility for the acts of a congress gathered together in so informal a fashion.—Yours, etc., SILVANUS P. THOMPSON.

July 22, 1896.

[The invitation referred to in the above letter reached us about four weeks ago, and was mentioned in our issue of June 26.—*E E.*]

A STUDY OF A THREE-PHASE MOTOR.*

BY C. W. VAN LAW AND H. S. SIMPSON.

The methods of testing, power measurement, etc., here described are applicable to machines of any size and power, and although the motor tested was a small one the results are typical of motors of this class.

The machine tested was a 3-h.p. Siemens and Halske motor, designed for three-phase currents at low periodicity and at a pressure of 115 volts. It was at first attempted to obtain the power required from two direct-current generators which had been fitted with collector rings for three-phase working, but it was found that these generators would not answer the purpose at all.

After some delay another direct-current generator was tried as an alternator, and found to give very fair results. The armature was of the Gramme type, wound with large wire and few turns per coil, giving a comparatively small self-induction. To convert this machine into a three-phase alternator the commutator was covered by an insulating sleeve of fibre, upon which were mounted three brass collector rings. These were separated by fibre rings, and were connected to three commutator segments 120deg. apart by set screws tapped through the fibre sleeve and into the segments. Thus between any two rings was embraced one-third the armature coils, and three-phase current could be led off from brushes resting on the rings.

The generator was driven from a De Laval steam-turbine which made 24,000 revolutions per minute. This, with 10 to 1 reduction gearing, and a bipolar field, gave a periodicity of 40. Ordinary excitation failed entirely. On open circuit, exciting from an Edison machine, 65 volts could be obtained, but this dropped to 35 on full load. Fluctuations in the Edison voltage also caused great trouble. To avoid these difficulties the following scheme was tried: only a part of the commutator was covered by the collecting rings, and it was determined to take direct current from the bare portion for the fields while taking three-phase current from the rings, thus making the machine self-exciting. This was tried, but variations in the load on the three-phase circuits so changed the "direct" voltage as to make this means unsuitable. We could get 100 volts or so for excitation when the motor was not connected, but this dropped to about 70 when load was thrown on.

This means also failing, the following was finally adopted, very satisfactory results being secured: the Edison generator was placed in series with the direct-current brushes on the generator in question This summation of potential gave 170 volts available for exciting purposes, which could be cut down to the desired amount by a rheostat and bank of lamps.

The fields were now saturated, so that fluctuations in the Edison voltage were hardly noticed. Still, the potential was much lower than was needed for the motor tests, and step-up transformers were resorted to. Only two of these could then be obtained, to transform up all three circuits. This was, nevertheless, accomplished by the following arrangement.

The two primary coils were connected in series, as were also the two secondaries. One brush of the dynamo was connected to the primary junction, and the other to the free ends. If the secondary ends be used as the three terminals of the system, three-phase current may be taken off just as from the machine, but raised in potential by the ratio of the transformer employed. Conard and Ehret transformers were used, and it was found possible, owing to their excellent regulation, to hold the motor's voltage at any point desired by slight variation in the exciting current.

The efficiency runs were first undertaken, the motor being tested at various loads up to 50 per cent. above its rated power, and at voltages from half its normal potential to somewhat above the figure for which it was designed. For these runs the following scheme of connections and arrangement of apparatus was adopted.

Three wires led from dynamo to motor, the two outside wires running to the instrument table and then back, while the third ran direct from one machine to the other, a light potential wire only being carried to the instrument table.

Wires 1 and 3 (Fig. 1) led through two ammeters, A A, of the Westinghouse "Station" type, and thence through the current coils of two Thomson recording wattmeters to the motor. The potential coils for these meters were connected between potential wire 2 and wires 1 and 3, as shown. Both meters were designated for 50 volts only, and to protect their potential coils at the higher voltages used, strings of lamps were connected in these two circuits as indicated in the diagram. Potential wire 2 could not then be connected at such a point as to give about 50 volts across the coils of the instruments. A small switchboard was so arranged that by placing voltmeter terminals in the appropriate clips, voltages could be read across any leg of the circuit (1-2, 1-3, and 2-3) or across the potential coils (1-1′ and 3-3′) very quickly and easily. The switchboard is shown in points 1′-1-2-3-3′ on the diagram.

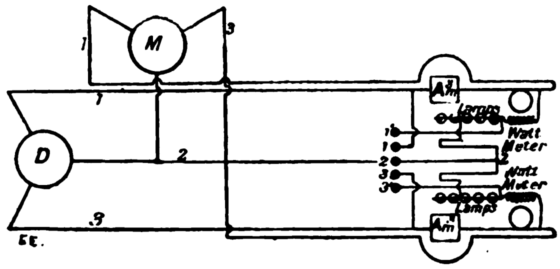

FIG. 1.

Load was applied to the motor by means of a special Prony brake, having water circulation to keep it cool. The load was increased by approximately equal increments from zero to a point where the safe current capacity of the machine was reached. At each load were taken the voltmeter readings referred to above, the wattmeter speeds—time in seconds of a given number of revolutions—ammeter readings in branches 1 and 3, brake load, and simultaneous speeds of dynamo and motor. From these data, and the instrument calibrations, the efficiency, etc., at the various points could easily be obtained.

During these runs one interesting fact was noticed. It may be proven that when the angle of lag in the individual circuits is greater than 60deg. one meter will run backward, and its readings must be subtracted from those of the other wattmeter. At 60deg. this meter stops entirely, while as the angle becomes less than 60deg. it starts again in a positive direction, running faster and faster as its load is increased This was observed during the tests—one meter at light loads running backward quite rapidly. As the load was increased it slowed up, stopped and started in a positive direction; its speed now increased with the load as the other meter had done all along.

At each of the voltages at which efficiency runs were made (65, 80, 95, 110, 115, and 120), a set of torque data was also obtained. Non-inductive resistance was introduced into each of the armature circuits, and the brake load increased as before up to the machine's capacity. At each brake load simultaneous speeds of dynamo and motor were taken, and the results were expressed in speeds in per cent. of synchronism and torque at 1ft. radius. Three different resistances were used at each voltage of approximately 10, 5, and 2½ ohms in each circuit, and these, with the data from the efficiency runs when the armature was short-circuited, gave four curves for each voltage.

In Fig. 2 is shown the efficiency curve taken at 115 volts, and typical for all the higher voltages. The showing

* From the *Electrical Engineer* (New York).

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made by the motor is remarkably good in many respects. In the case of most small motors the efficiency at anything but full load is very low; and the efficiency rising at once to a fairly high value, a maximum well within the capacity of the motor and a curve nearly flat through a wide range of load about its rated horse-power. Further, as seen from curve D of the torque curves taken at this same voltage (Fig. 3), the slip increases, but slightly from zero to full load, being only 10 per cent. at 50 per cent. overload. The machine can be run at much above its rated capacity, right along, without danger, and is most satisfactory in every way. The efficiency curves taken at other voltages possess much the same characteristics, that at 110 being the

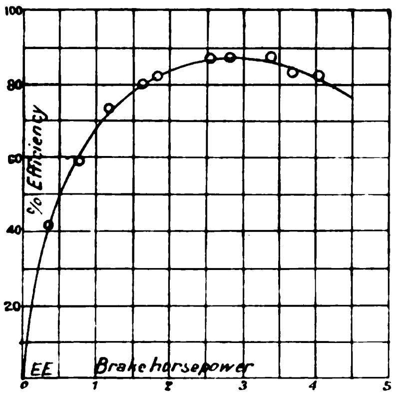

Fig. 2.

highest, reaching a maximum at 88 per cent., and being above 85 per cent. for quite a range of load. The efficiency at 65 volts—half the normal voltage—is still fairly high, reaching a maximum of 76 per cent., and being above 70 per cent. from less than ½ h.p. up. The power, however, is much less at these lower voltages, reaching a maximum of only about 1·3 h.p. for 65 volts.

The torque curves for 115 volts in Fig. 3 are of considerable interest as well. Curves A, B, C, and D are taken with 10, 5, 2½, and 0 ohms respectively, external resistance, approximately, in each armature circuit, for all runs. Curves "D" show only a slight slip from zero to full load for the higher voltages, but this rapidly increases as the lower voltages are used, and at 65 volts "D" drops 10 per cent. at less than half-load. The other curves are chiefly interesting as showing what starting torque might be expected with the various

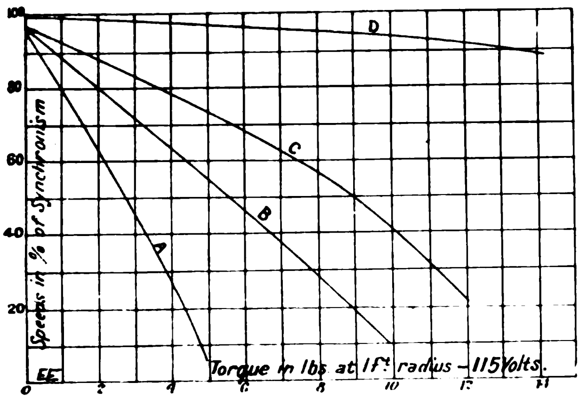

Fig. 3.

resistances used. By producing the curves to intersect the 0 speed line, the starting torque is evidently obtained, and is for the higher voltages amply high for the motor to start under full load, with 2½ ohms in each circuit. A certain resistance may be found for each voltage which will give maximum starting torque; if the resistance be either increased or diminished from this value the torque will fall off rapidly. If the armature be short-circuited, as it is when running at speed, the starting torque produced is very slight; and the machine will burn up before it can be got to start under load. Resistance must first be cut into the armature circuits till the machine starts, and then gradually cut out as the motor speeds up, the armature being fully short-circuited.

ALTERNATE-CURRENT TRANSFORMERS *

BY DR. J. A. FLEMING, F.R.S.

LECTURE I.

(*Continued from page 76.*)

Having thus seen the manner in which we can experimentally determine the form of an E.M.F. or current curve, which represents the different instantaneous values of a

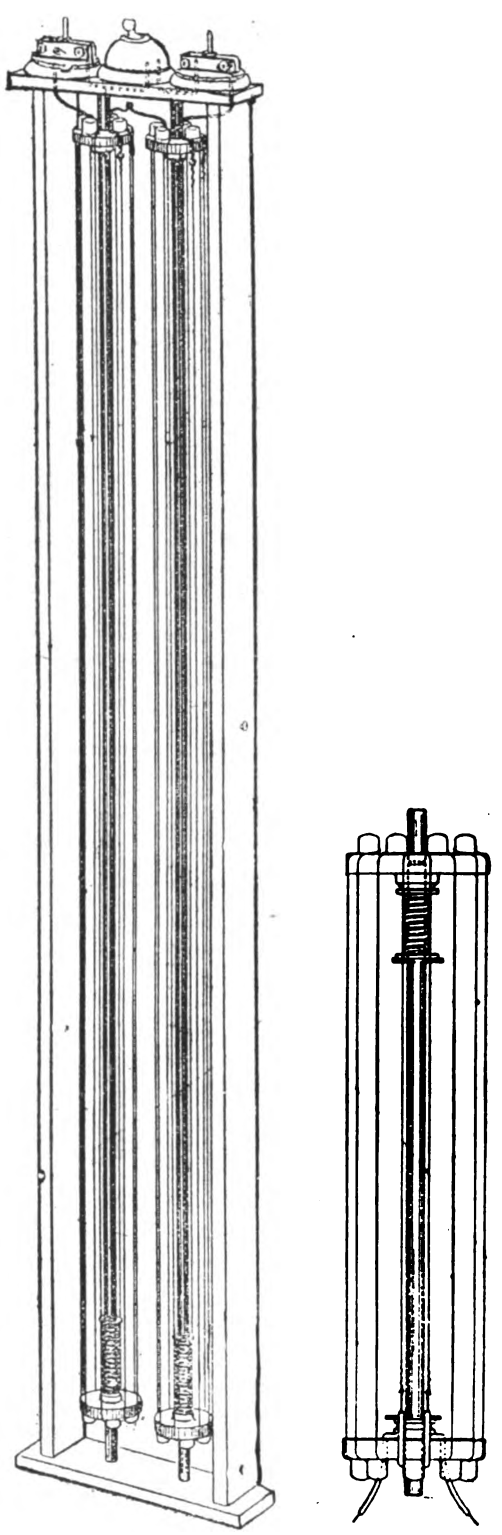

Fig 18

periodic E.M.F. or current, we can now proceed to discuss the manner in which these methods have been applied in the study of the alternate-current transformer. Let us first suppose that the transformer to be studied is a constant-potential transformer, having two windings, a primary and a secondary coil, both wound round an iron core forming a completely closed iron magnetic circuit. Let the primary coil be joined up through a non-inductive resistance, R^1, as shown in Fig. 2, with a circuit of constant potentials, and let the contact-breaker above described, denoted by C, and the electro-

* Cantor lectures delivered before the Society of Arts

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static voltmeter, V, be applied to determine the form of the current curve flowing into the primary coil, P, of the transformer. In order to delineate the form of the curve of primary potential difference, it is necessary to put across the primary terminals of the transformer a non-inductive resistance, R^2, which is divided in a definite ratio, so that by measuring a fraction, say 1-20, of the whole difference of potentials between the terminals of the primary circuit of the transformer we can determine the total potential difference. After much experimenting I succeeded in devising a form of resistance which is now before you, and which is very convenient for this purpose. It is called a resistance cage. It

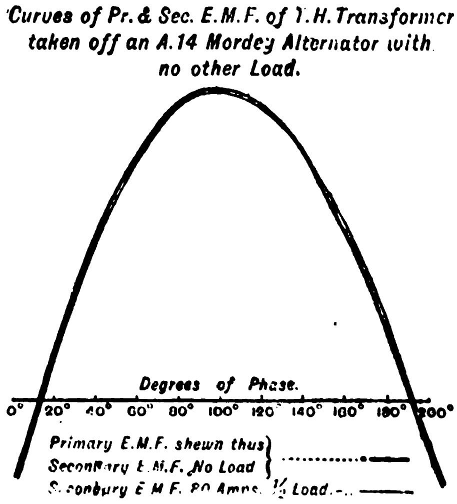

FIG. 19.

consists, as you see, of a series of brass rods held in a wooden frame, each rod carrying a pair of porcelain heads with porcelain pins on them (see Fig. 18), and these porcelain heads are kept pressed apart by a spring. Over the pins on these porcelain heads is wound, in zigzag fashion, a platinoid wire, so as to form a perfectly ventilated non-inductive resistance. Each of these resistances is adapted for withstanding 100 volts pressure, and carrying one-half or one ampere, and a series of 20 of these resistances can be put across the primary terminals of a transformer, and will withstand the pressure of 100 volts for as long as necessary. By measuring the fall of potential and delineating the periodic value of the difference of potential between the terminals of one cage, which forms one of a series of 20, we can delineate the whole difference of potential between the terminals of a transformer. In this way

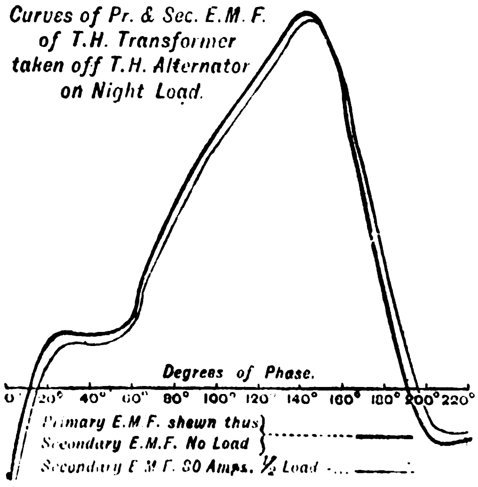

FIG. 20.

we can take curves of primary current and primary E.M.F. on the high-tension side of a transformer. In the next place we can perform the same operation on the secondary side of the transformer, and obtain the secondary terminal potential difference curve, and also, if the transformer is sending a secondary current, the secondary current curve for that transformer. When these experiments are carried out for any good closed-circuit transformer, and delineated in the form of a series of curves set in their proper relative position, which it is convenient to call a transformer diagram, we find the following results: In the first place, the curve of secondary potential difference is always an exact copy to a reduced scale of the curve of primary potential difference, and it is very nearly exactly in opposition to it in phase. This is shown in Fig. 19 and Fig. 20. Fig. 19 gives us the curves of primary and secondary E.M.F. of a Thomson-Houston transformer taken off a Mordey alternator. If the transformer is taken at no load, and if the curves of primary and secondary E.M.F. are drawn to such scale as to their maximum ordinates equal to one another, and if they are drawn on the same side of the axis then it is found that at no load the transformer curves exactly overlap one another. If the tranformer is partly or wholly loaded up on its secondary side, so as to cause it to send a secondary current, then the secondary E.M.F. is a little advanced in phase over the curve of primary E.M.F. as shown in Fig. 18. Fig. 20 shows the same thing for the same transformer taken off a Thomson-Houston alternator. Hence we see that the closed-circuit transformer acts like an electrical pantograph; it copies electrical potential difference, and the curve of secondary potential

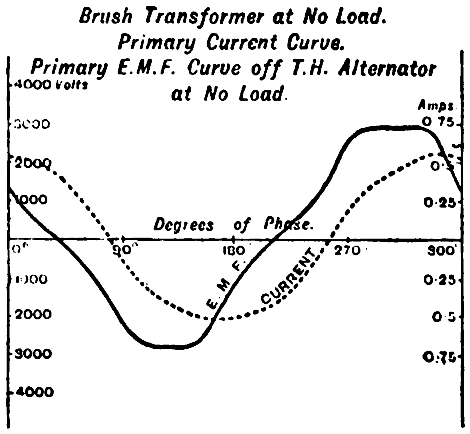

FIG. 21.

difference is always a nearly exact copy of the curve of primary potential difference; but to a reduced scale depending on what is called the transformation ratio of the transformer. On delineating the curve of primary current of the transformer when the transformer is taken at no load, as shown in Fig. 21, we see that the curve of primary current when the secondary circuit is open differs in phase from the curve of primary potential difference. It lags behind it, and the same thing is shown by reference to Fig. 14, where the curve of primary E.M.F. for another transformer taken off the same alternator is given. It will be seen that even if the same alternator is employed for the test, the curve of primary current at no load is not the same in form in the case of all transformers. The form of this primary current curve is governed by the nature of the iron employed in the core. We then notice that even in cases where the primary E.M.F. curve is more or less approximately a sine curve or simple periodic curve, the curve of primary current is always more irregular. Having in this manner delineated the curves

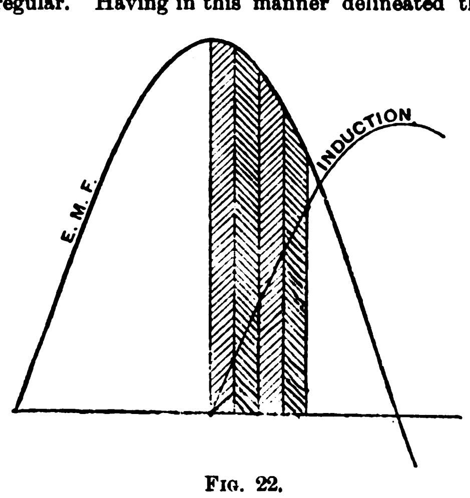

FIG. 22.

of primary current, primary E.M.F., and secondary current, we have then to determine the manner in which the induction in the core is varying with relation to these other varying quantities. We can draw out a curve of induction from the curve of a secondary E.M.F. in the following manner:

Since the secondary E.M.F. of the transformer at any instant is measured by the rate at which the magnetic induction linked with the secondary circuit is varying, we can construct the induction curve in the following way, as shown in Fig. 22. The curve marked E.M.F. represents a transformer secondary E.M.F. curve. The whole area of the curve is divided into two equal parts by a vertical line. Starting from this vertical line, half of the curve, say, the right-hand half, is divided up into narrow strips of equal area, which are represented by the

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cross-hatched slips. The areas of these very narrow slips are then taken with the planimeter, and we set off, starting from the middle point of the time axis, the curve of induction by the following method. Starting from the middle point of the time line we set-off on the right-hand side of the first slip an ordinate which represents to some suitable scale the area of slip No. 1. On the right-hand bounding line of slip No. 2 we then set-off an ordinate equal to the same scale of the total areas of slips No. 1 and 2 together. On the right-hand bounding line of the third slip we then in the same way set-off an ordinate representing the total area of the first three slips, and so on. In that way we obtain points on a curve which represents what is called the time integral of the E.M.F. curve, and this is, therefore, the proper representation for the induction curve. In order to determine the scale to which this induction curve is drawn we must know what is the value of the maximum ordinate of the induction curve. This can be done in the following manner.

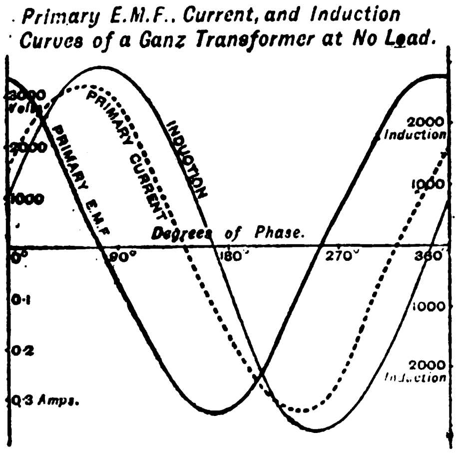

FIG. 23.

If B represents the induction in the core, S the cross-section of the core, N_2 the number of turns of the secondary circuit, n the frequency of the alternating current, and f the form-factor of the secondary circuit curve, then it can be shown that the root-mean-square value of the secondary E.M.F. is equal to $4 f . n . N_2 S B$, and hence, since the root-mean-square value of the secondary E.M.F. is immediately known from the delineated curve, and also its form-factor, we can easily calculate the value of B—that is, of the induction*—that is to say, in this manner not only can we thus delineate the curves of current and E.M.F., but also the induction, and represent them graphically on the same diagram. In Fig. 23 are shown the curves of primary E.M.F., primary current, and induction for a Ganz transformer taken at no load. The curve of induction can be determined in the above-described manner, not only from the curve of secondary E.M.F., but also from the curve of primary E.M.F.

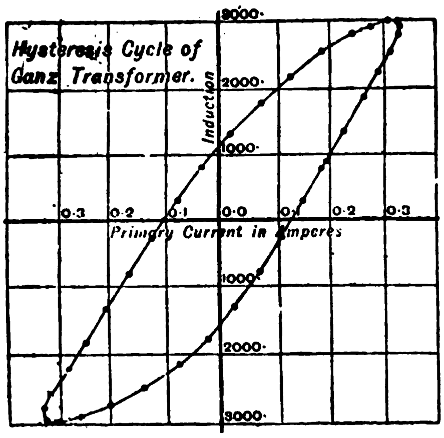

FIG. 24.

If this be done it is found that two curves of induction so obtained do not exactly coincide. The reason for this is the magnetic leakage of the transformer. This last term is best defined by saying that when the transformer is at work and sending a secondary current, the whole of the magnetic induction which is linked with the primary circuit is not linked with the secondary circuit. There is, as it were, an escape of induction from the secondary circuit which is called the magnetic leakage. In discussing in a later lecture the testing of a transformer we shall consider how this quantity can be measured. Having delineated the whole of these curves for a transformer, we are then in a position to draw a hysteresis diagram for the transformer. To do this, we have to set off in the form of a cyclic curve the variation of induction with magnetising force. It can easily be shown that if we construct a closed curve by setting off on a horizontal axis the different instantaneous values of the primary ampere-turns of a transformer on open secondary circuit taken at equal time intervals during the phase, and if corresponding with these we set off the vertical ordinates representing the total induction in webers in the core of the transformer corresponding to these different values of the ampere-turns, then the total area of that curve integrated in turns of a unit of area—one side of which represents a weber, and the other side of which represents an ampere-turn to the selected scale—will give us the value in joules of the energy wasted in the core of the transformer in one complete magnetic cycle, and in this manner we can determine from the transformer diagram the power wasted in watts in the core when the transformer is on open secondary circuit. This power is spoken of as the iron core loss in the transformer, and it can be determined directly from the transformer diagrams. In a later lecture we shall see how it can be more conveniently determined by one single direct measurement with the wattmeter. The diagram in Fig. 24 shows the hysteresis diagram thus determined for a Ganz transformer.

We have now briefly reviewed the chief actions going on in the transformer. Let us sum them up. If we apply to the terminals of a transformer a periodic E.M.F. varying according to any law, we find that we have a periodic current set up in the primary circuit which lags behind the primary E.M.F. when the transformer is an open secondary circuit, but which gradually comes into step with it in proportion as the transformer is loaded up. In good closed-circuit transformers a very small amount of loading up—even as much as one-fiftieth of full load—will suffice to bring the primary current curve into step with the primary E.M.F. curve. Secondly, we have a periodic magnetic induction in the core, which differs in phase, both from the primary current and the primary E.M.F., and it is found that this magnetic induction curve is always a more regular curve than the curve of primary E.M.F. When the curve of primary E.M.F. is approximately a simple periodic curve, then the curve of induction is more nearly a simple sine curve. Thirdly, we have a curve of secondary E.M.F. which is similar in form to, and exactly opposite in phase to, the curve of primary E.M.F. when the transformer is on open secondary circuit, or when it is sending a small secondary current into a non-inductive resistance. If the secondary circuit of the transformer is practically non-inductive, as it is when the transformer is working upon a load of incandescent lamps, then the curve of secondary current is always in step with the curve of secondary E.M.F., and can be deduced from it. Lastly, we have a curve deduced from the curve of induction and primary current of no load which give us the hysteresis curve of the transformer. The curve of primary current of no load is generally spoken of as the magnetising current, and the total power taken up in the iron core in watts is spoken of as the iron loss of the transformer.

* See "The Alternate-Current Transformer," vol. i. (new edition), p. 358.

LEGAL INTELLIGENCE.

QUESTION OF LIABILITY.

In the City of London Court, on Monday, before Mr. Commissioner Kerr, the case of the Cruto Incandescent Lamp Agency Limited, *v.* New and Mayne was heard. The plaintiff company, Dock House, Leadenhall-street, E.C., sought to recover the sum of £12. 3s. for electrical goods from the defendants, who are electrical engineers at Palace-chambers, Bridge-street, Westminster.

Mr. Bingley, counsel for the plaintiffs, said that the defendants had a branch office at Hull, and the plaintiffs received an order purporting to come from the defendants' Hull branch and signed by their manager (Mr. Fitzmorris). When the plaintiffs applied for payment of their account, they were told by the defendants in London that they had disposed of their Hull branch 12 months before to their late manager, and that if he had gone on using their paper, etc., it was not their (defendants') fault.

Mr. Whateley, defendants' counsel, said the defendants could not possibly be held liable for the acts of their manager after he had ceased to represent them, and after he had, in fact, taken over the business from them.

Evidence having been heard, **Mr. Commissioner Kerr** said the plaintiffs could not get over the fact that the defendants themselves had never ordered the goods which were being sued for. That being the case, there must be judgment for the defendants, with costs.

Verity's, Limited.—This is a new company, registered on July 9 by B. Verity, 39, Oakhurst-grove, Dulwich, S.E., with a capital of £2 000 in £1 shares, in order to carry on business as cycle manufacturers and electrical engineers in all or any of their respective branches. The Company is registered without articles of association.

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COMPANIES' MEETINGS AND REPORTS.

ELECTRICAL POWER STORAGE COMPANY, LIMITED.

The ordinary general meeting of this Company was held on Thursday week at the offices, Great Winchester-street, Mr. J. Irving Courtenay presiding.

The **Chairman**, in moving the adoption of the report and accounts, stated that the directors were able to recommend the same dividend as that which was paid in the previous year—5 per cent. Full provision had been made for maintaining their buildings and plant. The quantity of their manufactures sold during the year showed an increase, in spite of the keen competition. It had given them much pleasure to have M. Camille A. Faure, to whose brilliant invention in 1881 secondary batteries owed their commercial existence, associated with this Company's manager, Mr. Frank King, with the result that, after long and exhaustive experiments in the Company's laboratory, extending over a year and a half, a reduction in weight in the battery of over 40 per cent. and a reduction in space of 45 per cent. had been achieved, and this without any sacrifice of stability. The importance of these improvements in connection especially with autocars, tramcars, and self-propelled vehicles generally could not be over-stated, and they had just come when most wanted by engineers and the public. He had read with some surprise the statement in a report of the committee of the Glasgow Corporation that the combined system of the overhead trolley and accumulators which had been installed at Hanover, in Germany, was in their opinion objectionable. In consequence of this statement he had taken some pains to get official information, and he had found that the results of the installation were so favourable that the directors of the Hanover Street Tramways had resolved to increase very considerably the size of the installation. The installation generally appeared to have given every satisfaction, and had fulfilled all the claims made upon it, and it was important to notice that the financial results as regarded the maintenance of accumulators had been exceedingly satisfactory. Moreover, the local authority, which in this case was the police authority, confirmed the great superiority of the arrangement of accumulator traction in the town of Hanover over any other system of electric traction. He moved the adoption of the report and the payment of the dividend mentioned.

Sir Daniel Cooper seconded the motion, which was carried unanimously.

A vote thanks was passed to the manager and staff for their services during the year, and a special compliment was paid to Mr. Frank King in reference to the secondary battery.

Mr. King briefly replied, and the rest of the business, which was purely formal, consisted of the re-election of a director and the auditors and a vote of thanks to the chairman for presiding.

INDIA RUBBER AND TELEGRAPH COMPANY.

The adjourned special meeting of the shareholders of the India Rubber, Gutta Percha, and Telegraph Works Company, Limited, was held on Tuesday at Cannon-street Hotel, Mr. Matthew Gray presiding. It will be remembered that at the Company's meeting on the 7th inst. it was proposed to make certain alterations in the articles of association, and after discussion it was decided to adjourn the matter for a fortnight to allow the shareholders further time to consider them. The new articles proposed were given in our issue of July 10.

The **Chairman** now formally proposed and **Mr. W. S. Silver** seconded the adoption of the new articles.

Mr. Cochrane objected to the resolution on the ground that the existing articles made it compulsory on the directors to furnish the shareholders with fuller information in the accounts than they would have to give under the new articles, and asked on what ground the auditors suggested the proposed alterations. Fuller information had been repeatedly asked for from his (the shareholders') side of the table, and had been always refused. Items that should have been by the articles stated separately had been put together. Had they (the shareholders) been more sharp, they could have claimed the information they asked for as a matter of right under the articles. He (Mr. Cochrane) would like to hear from the auditor what the reasons for the alterations were.

Mr. Clarke (Messrs. Turquand, Youngs, and Co.) stated that personally he had audited the Company's accounts for only three years. He drew attention some time ago to the fact that the accounts were not quite in accordance with the articles, but it was considered that the words "as near thereto as circumstances admit" covered the case." As the result of further consideration, however, and on its being explained to him that to give the full details required by the articles would be prejudicial to the Company, he suggested that the articles should be altered as now proposed. He did not think for a moment that any objection would be raised to the proposals. The articles were in an obsolete and out-of date form. He (himself) had taken the same course in all the companies with which he was connected, and similar alterations had had the approval of Mr. Swinfen Eady. He (Mr. Clarke) had not at the time imagined that there would be any opposition to the proposal.

The **Chairman** said the Company was a trading one, and was bound to give tenders for supplying a great deal of the materials they manufactured. It was highly desirable that those tenders should not be known to competing firms. Some of their competitors had actually bought a few shares in their Company, and he could only imagine it was for the purpose of acquiring information. It was therefore desirable that while the auditor had full inspection of the accounts, the articles should not compel him to include in the published statement information that might be injurious to the interests of the Company. Moreover, the articles as they stood required a separation of the profits on different work, which was practically impossible.

The resolutions for the amended articles were carried, with one dissentient. There will have to be a formal meeting to confirm them.

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY, LIMITED.

The half-yearly general meeting of this Company was held on Tuesday at the offices, 38, Old Broad-street, Admiral Sir G. H. Richards presiding.

The **Chairman**, after referring to the death of Sir John Pender, who was the first chairman of this Company, said that they had no official business to transact, nor had the directors any accounts to place before the shareholders. Although they had not carried out any large contracts so far this year they had received orders from various companies and governments for several hundreds of miles of cable, a good deal of which had been completed. But, perhaps, the most important operations they had performed had been the repairing of different cables, all of which had been successfully accomplished. The principal of these had been the repairs to the French Telegraph Company's cable between Brest and New York. Although the Board were desirous of giving all the information they could to the shareholders they felt that it would be unwise to allude to any contracts of which they were not absolutely in possession, for experience had shown that there were always delays and disappointments in matters of this kind, especially when dealing with foreign countries. They proposed to pay the usual interim dividend of 12s. per share, being at the rate of 10 per cent. per annum.

No resolution was submitted.

BRITANNIA MOTOR CARRIAGE COMPANY, LIMITED.

The statutory general meeting of this Company was held on Tuesday at Winchester House, E.C., the Hon. J. H H. Berkeley (the chairman of the Company) presiding.

In the course of his speech to the shareholders, the **Chairman** referred to the prospectus, which did not state the nature of the motor. It could not, for various reasons, be either a water, steam, oil, benzine, or spring-driven motor, and therefore "any intelligent investor, seeing that it would not be driven by any of these powers, and understanding there is no such thing as perpetual motion, would know that there was only one other power available—viz., electricity." After mentioning that the motor had been on view in Tottenham Court-road, the Chairman continued: "Exception was taken that no reference was made that a battery would be necessary, and that a battery would add very considerably to the weight. Well, we were only advertising a motor; we had nothing to do with advertising a battery. We were pledged to no particular sort of battery, our intention being to use any battery which was most suitable for our motor, for we claim it can be driven equally well either with a secondary or primary battery, and in some instances no battery would be required, such as when the motor is on a tramcar, or for stationary work." The weight of the motor was about 100lb., and the additional weight of the battery for the horse-power employed would not be more than 518lb., what their 2-h p. motor was asked to do was one fifth of what the omnibus horses do in London; therefore the omission in stating that a battery would have to be employed was not of very material importance. Another criticism was that the motor would constantly require to be recharged, and the accumulators could not be charged in country places. Anyone living in a country place where there was not a supply of electricity would not use an accumulator, but a primary battery, which was quite as applicable to their motor. Anyone who applied for shares in a company exploiting a patent must be aware that he was dealing in a speculative company. They had had many offers for the motor from those who had seen it. From one well-known seaside town alone they had an offer to take a very large number. These were offers from hard headed business men who, having seen the motor, believed it would be put to practical use in competition with other motors that are being offered. In reply to a Shareholder who enquired as to primary batteries, the Chairman subsequently said, "at the present moment we have a primary battery offered to us which, if it fulfils all it is said to do, will answer every expectation. I do not think it would be desirable at the present moment to disclose any of the negotiations. It is stated here that the secondary battery would run from 60 to 100 miles. The inventor, Mr. Sherrin, has made a statutory declaration that with a battery and motor such as we have had he went 64 miles."

There was no resolution before the meeting, but a vote of thanks to the chairman and directors was proposed and carried.

EASTERN TELEGRAPH COMPANY, LIMITED.

The report of the directors of this Company for the half-year ended March 31 states that the revenue for the period amounted to £466,093, from which are deducted £99,152 for the ordinary expenses, and £33 956 for expenditure relating to repairs and renewals of cables, etc., during the half-year. After providing

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£4,413 for depreciation, £389 due to revaluation of currency assets, £5,806 for income tax, and transferring £20,000 to the fire insurance fund, there remains a balance of £302,377, to which is added £49,353 brought forward, making a total available balance of £351,730. From this balance there have been paid — interest on debentures and debenture stock £29,282, dividend on preference shares £20,296, an interim dividend of 2s. 6d. per share on the ordinary shares £50,000, leaving a balance of £252,152, out of which the directors have placed £10,000 to the reserve fund for maintenance ships and £125 000 to the general reserve fund. The directors now recommend the declaration of a final dividend for the year of 2s. 6d. per share and a bonus of 3s. per share, amounting together to £110,000, both payable on 23rd inst., free of income tax, and making with the three previous payments, a total distribution of 13s. per share, or 6½ per cent. for the year on the ordinary shares, and leaving £7,152 to be carried forward. The directors have appointed as chairman of the Company, in place of the late Sir John Pender, the Marquis of Tweeddale, who has been vice-chairman since 1874. They have also appointed the present managing director (Mr. J. Denison Pender) as vice-chairman, and Mr. C. W. Earle a director of the Company.

The ordinary general meeting of this Company took place yesterday (Thursday) at Winchester House E.C., the Marquis of Tweeddale presiding. Resolutions for the dividend, etc, were carried on the motion of the Chairman, seconded by Mr. J. D. Pender. There was also a motion of condolence with the family of the late Sir John D. Pender, which was proposed by Mr. J. Gibbs and seconded by Mr. H. Burcher.

CITY AND SOUTH LONDON RAILWAY COMPANY.

Directors: Charles Grey Mott, Esq. (chairman), Harrow Weald, Middlesex; Charles Seymour Grenfell, Esq., Elibank, Taplow; Sampson Hanbury, Esq., Wyvenhoe Park, near Colchester; S. Barclay Heward, Esq., 96, Ashley-gardens, Westminster; Edwin Tate, Esq., 21, Mincing-lane E.C.

Report of the directors, with abstract of accounts for the half-year ending June 30, 1896, to be submitted to the half-yearly ordinary general meeting of the Company, to be held at Winchester House, Old Broad-street, E.C, on Tuesday, July 28, 1896, at 12 noon:

The receipts from all sources for the past half-year have amounted to £24,910. 18s. 9d., and the cost of working has been £15,001. 17s. 10d., leaving a profit of £9,909. 0s. 11d. Inclusive of the balance brought forward from December 31 last, the net revenue account shows an aggregate total of £11,158. 5s. 2d. After making provision for the debenture and debenture stock interest, a balance remains available for dividend of £7,499. 1s 8d. Out of this sum your directors recommend that the full dividend of 5 per cent. per annum be paid on the preference shares, and that a dividend at the rate of 1⅜ per cent. per annum be paid upon the consolidated ordinary stock, leaving a balance of £1,072. 5s 6d. to be carried forward to the next account. The following table shows the number of passenger, exclusive of season-ticket holders, carried since the opening of the railway in each half-year:

Half-year ended	Number of passengers (exclusive of season-ticket holders).	Receipts (including season tickets).		
Dec. 31, 1890 (11 days)	165 000	£1 568	3	9
June 30, 1891	2 412,343	19,403	6	9
Dec. 31, 1891	2,749,055	19,798	16	6
June 30, 1892	2,813,162	20,931	4	2
Dec. 31, 1892	3,117,602	22,002	17	5
June 30, 1893	3,146,656	22 458	6	9
Dec. 31, 1893	3,093,351	22,067	14	10
June 30, 1894	3,383,154	23,564	10	6
Dec. 31, 1894	3,275 649	23 540	12	4
June 30, 1895	3,113,199	23 711	5	8
Dec. 31, 1895	3,172 438	23 780	3	7
June 30, 1896	3 192,672	24,021	13	0
Total since the opening of the line	33 634,281	£246,848	15	3

The exceptionally mild winter and the extremely fine weather since experienced have, there can be no doubt, militated against the traffic of the line, and it is satisfactory that, in spite of these adverse conditions, the returns for the half-year show an increase both in the number of passengers carried and in the amount of receipts. The alterations at the City station have proved, as was anticipated, of considerable advantage in coping with the traffic in the busy hours of the day. The new coaches, and the locomotive constructed in the Company's own shops, are now in use with satisfactory results. The generating plant, locomotives, and rolling-stock have been well maintained, and are in good working order and efficiency. During the half-year, a further sum of £8,400 5 per cent. terminable mortgage bonds has been paid off. The erection of the condensing plant is now proceeding rapidly. This work has been somewhat delayed through the anxiety of your directors to avail themselves of the latest improvements with the view of obtaining as perfect an apparatus as possible. Active steps are now in progress for the acquisition of the sites required for the stations at London Bridge and Finsbury-pavement, and tenders have been invited for the construction of the works. Acting under the authority given by the proprietors at the last half-yearly meeting, the 20,000 5 per cent. perpetual preference shares then authorised have all been placed at a considerable premium, it being stipulated that no dividend shall accrue upon those shares until after January 1, 1899, by which time it is expected the extension will be finished and open for traffic. The Bill for the extension of time for the completion of the works authorised by the Company's Act, 1893 (Islington Extensions) has been considerably delayed owing to the opposition to the powers granted by the original Act for the acquisition of the site of St. Mary Woolnoth Church. In the first instance the rector and churchwardens of that church desired that the building should not be removed, and upon their opposition the House of Commons Committee inserted a clause in the Bill for the preservation of the fabric of the church, but when the Bill came before the Committee of the House of Lords, the rector and churchwardens informed that committee that, under the circumstances, they preferred that the church should be pulled down, and the committee thereupon struck out the clause inserted in the Commons. It is hoped that the Bill will now meet with no further opposition during its remaining stages,

Dr. REVENUE ACCOUNT.	£	s.	d.
Maintenance of way, work, and stations	658	7	2
Locomotive and generating power	5,446	8	3
Carriage repairs	528	12	1
Traffic expenses	5,838	0	8
General charges	1,750	18	9
Passenger duty	52	6	7
Law charges	2	12	6
Rates and taxes	724	11	10
	15,001	17	10
Balance carried to net revenue account	9,909	0	11
	£24,910	18	9
Cr.	£	s.	d.
By passengers (3,192 672)	22,817	14	8
Season-tickets (482)	1 203	18	4
	24.021	13	0
Parcels, etc.	94	13	6
	24,116	6	6
Transfer fees	23	12	6
Rent of property	676	13	2
Sundry receipts	94	6	7
	£24,910	18	9

Dr. GENERAL BALANCE SHEET.	£	s.	d.
Balance from net revenue account	7,499	1	8
Unpaid interest and dividends	100	9	11
Interest payable or accruing and provided for	1,213	0	2
Sundry outstanding accounts	4,727	10	0
	£13,540	1	9
Cr.	£	s.	d.
Cash at bankers, current accounts	3,956	1	2
Cash in hand	741	11	1
General stores—stock of materials on hand	3,627	1	11
Sundry outstanding accounts	605	4	4
Balance from capital account	4,610	3	3
	£13,540	1	9

CROMPTON AND CO., LIMITED.

Directors: John Trotter, Esq., chairman; Rookes Evelyn Bell Crompton, Esq., and John Francis Albright, Esq, managing directors; Bernard Gibson, Esq.; Carleton F. Tufnell, Esq.

Eighth report of the directors to be presented at the annual general meeting of the shareholders to be held at the City Terminus Hotel, Cannon-street, E.C, on Monday, July 27, 1896, at 3 p.m.:

By the fire at the Chelmsford works of the Company as reported by circular to the shareholders in November last the offices of the Company were, with the whole of their contents, including all the books of account there, and drawings, utterly destroyed, and as a consequence the directors are unable to present to the shareholders the usual statement of profit and loss for the past year. The directors have thought it best to have a complete revaluation made of all the Company's property and assets as at March 31 last, and the statement so prepared they now submit to the shareholders. The loss of property by the fire has been made good by the insurance companies, and the amount has been partly reinvested in similar assets, leaving a balance of £26 585 which has been placed on deposit to be applied only in restoration. The directors, owing to the growth of the business and the demand of the insurance companies that the generating station for the lighting of Chelmsford should be detached from the manufactory, have decided, after careful consideration, that it is advisable to construct new works upon a more convenient site, and they have accordingly purchased nine acres of freehold ground adjoining the railway at Chelmsford, and contracts have been let for the erection of commodious works with a siding on to the railway. The directors believe that these works, situated on the main line of railway and fitted with all modern appliances, will place the Company in a far more favourable position for manufacturing economically and rapidly than it could ever have attained at the old site. The Chelmsford Electric Lighting Company, Limited, is making very satisfactory progress. The station for generating the electrical energy has hitherto formed part of the manufacturing premises of this Company, and a fixed charge per unit has been made for current supplied to the lighting company. It is now, however, proposed that the electricity station which is being re-erected and

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equipped after the fire shall be sold outright to the lighting company, which will thenceforward carry on its own business independently. Although the insurance companies have paid for the property actually destroyed by the fire, the consequential damage to the Company has been very great. Owing to the serious interruption to the business, and the greatly increased costs of manufacturing in temporary premises since the fire, a heavy loss has been incurred by the Company. The statement now presented shows a balance of £10,051. 0s. 11d. to the debit of the revenue account, to which must be added £1,000 as a provision for doubtful debts; and as this loss is entirely owing to the exceptional circumstance of the fire, the directors propose to place the amount to a suspense account. It is with much pleasure the directors have to report that the order book of the Company is so full that a larger number of men are employed at Chelmsford than has ever been necessary before, and the prospects for the future are most satisfactory and encouraging. The directors regret that, as announced at the general meeting last year, Viscount Emlyn has retired from the position of chairman of the company in consequence of his having been appointed chairman of the Great Western Railway. The Board have elected Mr. John Trotter to fill the vacancy thus caused, and a resolution will be submitted confirming this appointment. In accordance with the articles of association Mr. Carleton F. Tufnell retires from the Board of directors by rotation, but offers himself for re election. The auditors, Messrs. J. H. Duncan and Co., also offer themselves for re-election.

STATEMENT OF LIABILITIES AND ASSETS AT MARCH 31, 1896.

Capital and Liabilities.		£ s. d.
Authorised issue, 56,000 shares at £5		280,000 0 0
Ordinary shares, 4,000 issued as fully paid	£20,000 0 0	
Ditto, 1,928 shares, £1 called, £1,928; payments in full, £24	1,952 0 0	
		21,952 0 0
Preference shares, 28,180 at £5		140,900 0 0
		162,852 0 0
Debentures, 5 per cent.		82,850 0 0
Loans from bankers		14,606 7 8
Sundry creditors		43,001 11 6
Three months' debenture interest accrued		1,001 2 1
Doubtful debts and contingencies account		311 13 11
Unclaimed dividends		12 7 9
		£304,635 2 11

Property and Assets.	£ s. d.
Freehold property	12,780 4 0
Plant, tools, furniture, fixtures, etc.	38,999 10 0
Stock in-trade	57,834 12 7
Work in progress on contracts	6,848 9 1
Trade debtors	58,375 8 8
Investments in shares of other companies	2,911 0 11
Chelmsford Electric Lighting and other subsidiary companies	28,082 12 7
Cash at bankers and in office	29,447 0 11
Suspense account—preliminary expenses, premium on debentures paid off, and costs of issue of debentures	9,775 3 3
Patents account	13,790 0 0
Electric cooking and heating department, cost of establishing	5 740 0 0
Goodwill	30,000 0 0
Revenue account balance	10,051 0 11
	£304,635 2 11

REVENUE ACCOUNT.

Dr.	£ s. d.
Interest on debentures	4,076 17 0
Interest on bankers' advances	1,074 0 3
Directors', managing directors', trustees', and auditors' fees	2,060 12 1
Income tax	185 18 8
Loss for the year	5,132 13 2
	£12,530 1 2

Cr.	£ s. d.
Balance from last year	1,343 15 9
Reserve fund	1,135 4 6
Balance March 31, 1896	10,051 0 11
	£12,530 1 2

NATIONAL TELEPHONE COMPANY, LIMITED.

The report of the directors of this Company for the half-year ended June 30 states that the income accrued in respect of the business of the half-year amounts to £429,681, as compared with £396,385 for the corresponding period of 1895, being an increase of £33,295. The working expenses amount to £226,250, as against £207,628, being an increase of £18 622. The net result for the half-year (after deducting the Post Office royalties, amounting to £38,958) is a profit balance of £164,472, as compared with £152,322 for the corresponding period last year, being an increase of £12,150. The rentals carried forward for unexpired terms of running contracts amount to £438,322, an increase of £47,343 over the corresponding period in 1895. Out of the available balance of £136,612 the Board will recommend the payment of a dividend at the rate of 6 per cent. per annum, less income tax, on the first and second preference shares; 5 per cent. per annum, less income tax, on the third preference shares; and 5 per cent. per annum, free of income tax, on the ordinary shares. The Board also propose to transfer £35,000 to reserve, and to carry forward £17,133. The sum of £248,537 has been expended upon additional exchange and private lines erected during the half-year. A not inconsiderable proportion of this outlay is attributable to the substitution of metallic circuits for single lines and the construction of underground work in lieu of overhead wires; both these sources of expenditure having become necessary to ensure greater efficiency in the service to subscribers in the more important and crowded centres. In accordance with the agreement arrived at between the Post Office and the Board, the trunk lines from time to time erected by the Company were surrendered to the State on April 4 last in consideration, amongst other things, of the payment on the same date of their value as ascertained and fixed by experts after an elaborate and prolonged enquiry. This transfer, separating the conduct of the trunk business from the working of the local exchanges in the numerous areas assigned to the company, has naturally involved some inconvenience in connection with the "through" telephone business of the country, but as the authorities of the Post Office and the officers of the Company are loyally co operating with the object of securing to the public the most efficient service possible, it is hoped that the inconvenience adverted to may be speedily terminated. The Board have long had under consideration the advisability and necessity of establishing a pension fund for the benefit of the officers, clerks, and others in the service of the Company. The Board have had the advantage of the experience and advice of an eminent actuary familiar with the principles and details upon which many such funds have been founded, and are now working successfully, and felt that they would have the support and sympathy of the shareholders in dealing with the matter in a generous spirit, by making the annual contribution of the Company to the fund sufficient to ensure its stability and to provide for the case of those officers and servants who, having already been in the service some years, would otherwise be placed at great disadvantage in realising the benefits of the fund in comparison with new and younger members of the staff.

The general meeting takes place on the 30th inst.

DIRECT UNITED STATES CABLE COMPANY, LIMITED.

The report of the directors of this Company for the six months ending June 30 states that the half year's revenue, after deducting out-payments, amounted to £42,457, as compared with £37,653 for the corresponding period of 1895, being an increase of £4,803. The working expenses for the same period, including income tax, but exclusive of cost of repairs of cables, amounted to £19 692, leaving a balance of £22,764 as the net profit of the half-year, making, with £4,149 brought forward, a total of £26,913. For the corresponding period of 1895, the working expenses and other payments amounted to £18,909. Three quarterly interim dividends, amounting to £19,731 have been declared and paid during the financial year, and a final payment of 2s. 6d. per share is now proposed, making, with the three interim dividends, 2¼ per cent. for the year, being a total distribution of £27,319. After transferring £7,500 to the reserve fund, the balance of £4,235 is proposed to be carried forward. The directors have appointed Mr. E. M. Underdown, Q.C., to be chairman, in place of the late Sir John Pender. The cable repairs in progress in December last were satisfactorily completed early in January at a further cost, including new cable inserted, of £8,244, which has been debited to the reserve fund account, the balance of which, with the addition of interest, realised profit, and amount transferred from revenue account, now stands at £313,969.

The general meeting takes place on the 28th inst.

ANGLO-AMERICAN TELEGRAPH COMPANY, LIMITED.

The report of the directors of this Company for the past half-year states that the total receipts from January 1 to June 30, including the balance of £794 brought forward from the last account, amounted to £154,832 The traffic receipts show an increase of £11,917, as compared with the corresponding period of last year. The total expenses of the half-year, including the repair of cables, etc., as shown by the revenue account, amounted to £57,029, being an increase of £1,645. The directors, under the powers conferred upon them by the articles of association, have, before declaring the net profits, set apart the sum of £12,000 to the renewal fund, leaving a balance of £85,803. One quarterly interim dividend of 12s per cent. on the ordinary and of £1. 4s. per cent. on the preferred stock was paid on May 1 last, absorbing £42 000, and a second quarterly dividend of 12s. per cent. on the ordinary and £1. 4s. per cent. on the preferred stock, amounting to £42 000, will be paid on August 1, leaving a balance of £1,803 to be carried forward to the next account. The general meeting takes place to-day (Friday).

GLOBE TELEGRAPH AND TRUST COMPANY, LIMITED.

The report of the directors of the Globe Telegraph and Trust Company, Limited, for the year ended July 18 states that the net revenue for the year, after deduction of expenses, amounts to £185,223, and makes, with the balance of £1,238 brought

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forward, a total of £186,461. From this amount there has been distributed the sum of £125,614 in interim dividends, leaving an available balance of £60,847. The directors recommend the payment of a final dividend for the year of 3s. per share on the preference shares, and of 3s. 9d. per share on the ordinary shares, making with previous distributions a total dividend for the year of 6 per cent., less income tax upon the preference and 4½ per cent. net (against 4½ per cent. for the preceding year) upon the ordinary shares, leaving a balance of £948 to be carried forward. The directors have deemed it advisable in future to pay the interim dividends on October 31, January 31, and April 30 in each year, the date of the final dividend remaining unchanged. Since the last meeting the remainder of the money resulting from the paying off of the Direct Spanish Telegraph Company's 6 per cent. debentures has been reinvested. The directors have appointed the Marquis of Tweeddale as chairman, in place of the late Sir John Pender. The shareholders' meeting is fixed for the 28th inst.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Odessa.—The Municipal Authorities will receive tenders up to August 13 for street electric lighting and for the lighting of the new prison.

Nava del Rey (Spain).—The Municipality are open to receive tenders up to August 28 for the electric lighting of Nava del Rey for a period of 20 years.

Brussels.—Tenders are requested by July 26 for repairs and renewals of lightning conductors for the local administration Applications to rue des Augustins 17, Brussels. The amount is about £400.

Mons.—Tenders are required for the construction of an electric generating station building for the Tournai Asylum. Particulars at Brussels, rue des Augustins 17, and tenders will be received up to August 3.

Vich (Spain).—The contract will be allotted by the municipal authorities of Vich on August 17 for the electric lighting of the town for 10 years from June, 1897. The annual payment proposed is about £800.

Halifax.—Firms desiring to tender for the electric lighting and hoists at the new infirmary to be built for the Guardians of the Halifax Union must apply before August 13 to the architects, Messrs. Horsfall and Williams, George-street and deposit two guineas with the Clerk to the Guardians, Union Offices, Halifax.

London, E.C.—Messrs. Hazell, Watson and Viney, Limited, invite offers for a motor van, suitable for carrying large quantities of paper between Aylesbury and London (30 miles). High speed not essential. Address offers, marked "Motor Van Tender," care of Hazell, Watson, and Viney, Limited, 1, Creed-lane, London, E.C.

Hapton (Padiham, Lancs.).—Tenders are wanted for lighting Hapton township with electricity from September 1, 1896, to April 30, 1897, for the Parish Council. Endorsed tenders should be sent to Mr. E. O'Shaughnessy, clerk, St. Anne's-terrace, Padiham, by August 3. Full particulars can be obtained on application to the clerk at that address.

Simla (India).—The Municipality is inviting tenders for lighting by electric light for a term of years the principal thoroughfares and buildings belonging to the Municipality. Tenders must be submitted by September 1 next. Should any proposal be accepted, the Municipality will afford the successful tenderer all facilities to extend the system of lighting to private houses.

Cologne.—Tenders are required by the Municipal Authorities for the construction and working of electric tramways in the city of Cologne to an aggregate length of 20·3 kilometres (12¼ miles). Specifications, plans, and particulars are obtainable for 10 marks (10s.) from der Registrateur B, des Oberbürgermeisteramt, Köln, Germany, and tenders must be in by November 6.

Madras.—Tenders are invited for the lighting by electricity of Government House, Madras, including the banqueting-hall and aide-de-camps' bungalow, and also for the lighting of Government House, Guindy, including the military secretary's bungalow. For particulars application must be made to the consulting architect to the Government, Chepank, Madras. Tenders will be opened on November 11, 1896.

Blackpool.—The Corporation require tenders for the supply of coal and oil to the electricity department. Specifications may be obtained on application to Mr Robt C. Quin, borough electrical engineer, Corporation Electricity Works, West Caroline street, Blackpool, and sealed tenders must be delivered at the electricity works not later than 10 a.m. on 27th inst., addressed to the Chairman of the Electric Lighting Committee, and endorsed "Tender for Coal" and "Tender for Oils" respectively.

San Juan (Puerto Rico).—H.M. Secretary of State for Foreign Affairs has received from H.M. ambassador at Madrid a copy of a Spanish Royal Order which has appeared in the *Gazette* inviting tenders for the construction and working of a telephone system in San Juan de Puerto Rico. A deposit of 800dol. must accompany each tender, which will be considered on August 10. The copy of the Royal Order may be seen on application to the Commercial Department of the Foreign Office between the hours of 11 and 6.

Voghera (Italy).—In view of the expiration of their contract with the local gas company in 1898, the municipal authorities of Voghera are desirous of receiving during the present year propositions for the lighting of the town either by the electric light or a mixed system of gas and electricity. The population is 16,000. Application should be made to L'Administrazione Comunale, Voghera, who will give all particulars necessary.

Mexico.—The municipal authorities of the city of Mexico are prepared to receive proposals for the street lighting by incandescent lamps for a period of eight years Tenders should be sent in by August 31. The Secretary of State for Foreign Affairs has received from the British Consul at Mexico a pamphlet issued by the Municipal Council of the city containing particulars as to the tenders, and this may be seen on application to the Commercial Department of the Foreign Office between the hours of 11 and 6.

Southampton.—The Harbour Board invite tenders for the construction and erection of four electric cranes and accessories, and also for alterations to gantry of an existing crane, on the Town Quay, Southampton. Specification, with two general drawings attached, may be obtained on and after 20th inst. from Mr. A. H. Skelton, clerk, Town Quay, Southampton, upon payment of £3. 3s , which will not be returned, and further detailed plans may be seen at the office of the electrical engineer, Mr. J. G. W. Aldridge, 9, Victoria-street, Westminster, S.W. Sealed tenders, marked "Tenders for Electric Cranes," should be sent to the clerk by August 10.

Hull.—Tenders are required by the Electric Lighting Committee for the supply of best South Yorkshire hard steam doubled-screened nuts for 12 months ending June 31, 1897, in accordance with the conditions set forth in the form of tender, which may be obtained at the Electric Lighting Offices, Dagger-lane. The contractor will have to enter into the usual form of contract required by the Corporation. Tenders, endorsed "Double-Screened Nuts for Electric Lighting Station," to be sent, under seal, to the chairman of the Electric Lighting Committee, Town Hall, by noon on 30th inst. Mr. A. S. Barnard, borough electrical engineer, Electric Lighting Station, Dagger-lane.

Mile End (London).—Tenders are wanted for the supply and erection of electrical plant, laying down electric mains, and wiring, for lighting premises in Bancroft-road, London, E , by electricity, for the Guardians of Mile End Old Town. Plans may be seen, specifications and full particulars obtained from Mr. C. F. Burden, architect to the Guardians, at his office on the premises, between 10 a.m. and 4 p.m., on production of a receipt from Mr. William Thacker, clerk, Bancroft road, London, E , of the deposit of a £5 Bank of England note, which will be returned on receipt by the Guardians of a bona fide tender, accompanied with such specification. The acceptance of a tender will be subject to the Local Government Board's approval of the scheme, etc. Tenders must be delivered by noon on 30th inst.

Kingston (Jamaica).—The Colonial Government invite electric tramway contractors willing to undertake the establishment and working of a system of rapid transit to send in applications for the grant of a license by the Governor in Privy Council under the Tramways Law, 1895. In all applications the principal questions to which attention should be directed are the following : (*a*) the amount of capital which the applicants are prepared to subscribe ; (*b*) the system which it is proposed to establish ; (*c*) the mileage of lines to be laid ; (*d*) the fares to be charged ; (*e*) the frequency of the service ; (*f*) the length of the license required by applicants ; (*g*) the guarantee which the applicants offer for the satisfactory performance on their part of any obligations devolving on them. Plans of the city of Kingston and part of the parish of St. Andrew, showing the routes on which the present tramway lines are laid, and copies of the law under which licenses are granted and of the rules made thereunder by the Governor in Privy Council, may be seen at the office of the Crown Agents for the Colonies, Downing-street, London, S.W. All applications must be delivered not later than July 31, 1896, in a sealed packet, marked on the outside "Application for Tramway License," to the clerk of the Privy Council, Kingston, Jamaica. Kingston has its principal means of transit at present supplied by the Jamaica Street Car Company by horse tramcars, the entire length of lines laid being about 12 miles. The concession granted by the Legislature of the island to the Jamaica Street Car Company will shortly expire.

RESULTS OF TENDERS.

Harrogate.—The Town Council have accepted the tender of Mr. J. Stephenson for the construction of a feed-water reservoir at the generating station.

Logan (Utah).—The contract for lighting the city by electricity has been obtained by the Hercules Power Company. By the terms of the contract the company agree to run 25 street lights of 1,200 c.p , with 16 incandescent lamps for inside use, at about £190 a year, the contract to be for two years, and the company to have the city's plant for the consideration of one dollar a year The Council could not make the undertaking pay.

Catalogues.—We have received from Messrs. C. W. Treacher and Co., of 165, Queen Victoria-street, E.C., their catalogues of telephones and bells, and of electric lighting material and apparatus. We hope to notice these catalogues at greater length shortly. We have also received, and reserve for further notice, Messrs. Rosling and Appleby's catalogue of dynamos, motors, and electrical machinery. Mr. F. C. Allsop's catalogue of electrical instruments must be similarly reserved.

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BUSINESS NOTES.

Dover.—The Lord Warden Hotel has been fitted throughout with electric lights and lifts.

Western and Brazilian Telegraph Company.—For the past week the receipts were £2,762

West India and Panama Telegraph Company.—For the two weeks ended July 15 the receipts were £1,181.

Precautions Against Fire.—Messrs. Merryweather have just fitted hydrants, hose and other appliances at the St. Mary (Islington) and Chelsea electricity supply central stations.

Bucklow.—The Altrincham Electric Supply Company have given notice that they are about to break up about 200 yards of road for the purpose of laying down further mains at Bucklow.

Ayr.—Extensions of the electric lighting have been decided upon by the Town Council to Seafield at a cost of £264. 13s. 9d , and along Carrick-road, Broomfield road, and Racecourse View-road at a cost of £309. 7s. 6d.

Southwark (London).—The electric light is being installed into St. George's Cathedral and the work has been entrusted to Messrs. Fred. A. Donnison, Berlyn, Evans, and Co., of 116, Great Portland street, W.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending July 19 amounted to £1,267, as compared with £1,226 in the corresponding week of the previous year, being an increase of £41.

Govan.—The Burgh Commissioners have granted permission to Messrs. Simpson and Wilson, engineers of the subway, to erect an electric lamp at the corner of Paisley-road and Cessnock-street as a guide to their station in that quarter.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ending July 17 were £2,497. 15s. 6d., compared with £2,009. 9s. for the corresponding period of last year, being an increase of £488 6s. 6d.

Glover and Co.—The annual outing of the employés of Messrs. F. A. Glover and Co , of 97, Queen Victoria-street, E C , took place on Saturday last at Margate. The dinner was at the Margate Hotel Metropole, and Mr. F. A Glover presided.

Dublin.—At a meeting of the shareholders of the Dublin United Tramway Company the formal resolution has been passed authorising the purchase of the electric system of the Southern District Tramways Company for a sum of £273,000.

St. Pancras (London).—It has been proposed that the Baths and Wash-houses Committee should consider the advisability of installing the electric light at the baths and wash-houses, current to be priced at 5d. per unit as though for public street-lighting.

Chester.—Mains are now being laid in Bridge-street, Grosvenor-street, Pepper-street, St. John's-street, Eastgate-street, Foregate-street, Northgate-street, Town Hall-square, Watergate-street, and Nicholas-street. The price of current will be 6d. per unit.

Walsall.—At the monthly Town Council meeting the Town Clerk read a memorial signed by 75 tradesmen, etc , in favour of lighting High-street and Digbeth with the electric light. The memorial was referred to the Streets Committee for consideration.

Victoria (British Columbia).—The Consolidated Electric Railway Company has purchased the electric railway lines in this city, which were sold by auction recently. The company is an English syndicate, and owns the Nanaimo, Vancouver, New Westminster, and Victoria electric railways.

City and South London Railway.—The returns for the week ended July 19 were £857, compared with £831 for the corresponding period of last year, being an increase of £26. The total receipts for the half-year 1896 were £2,675, compared with £2,594 last year, being an increase of £81.

Glasgow.—It has been stated that the Corporation have practically decided to give the overhead electric traction system a trial on a small portion of their tramway system. No formal pronouncement has been made by the committee, but it is understood that this course will probably be adopted.

Eastern Extension, Australasia, and China Telegraph Company.—At a meeting of the Company on Wednesday, the Marquis of Tweeddale was appointed chairman of the Company in succession to the late Sir John Pender. Mr. F. E. Hesse was at the same time appointed manager as well as secretary.

Kirkcaldy.—At a meeting of the Town Council a report by Prof. Kennedy on the introduction of the electric light was considered. It showed that the new light could be conveniently introduced to Kirkcaldy at a cost of £20,000. It was agreed to remit the matter to a committee for recommendation.

Dover.—The Town Council have decided to await the report of the committee on the Rouen tramways before referring it to the surveyor to prepare plans for the tramways to be constructed and report on the system of traction to be adopted. The matter will come before the Council again at the next meeting.

D.P. Accumulators.—We have received from the D.P. Battery Company, of 66, Victoria-street, S W , a price list of the storage batteries. The list is headed with the statement that there are "eight miles of the cells in daily use." A number of testimonials from electrical engineers and private users are appended.

Swansea.—The Town Council have decided, instead of confining it to two local firms, to put the supply of an electric lighting installation for the market out to tender. Mr. Manville is the consulting engineer. The "triple scheme"—lighting, tramways and destructor—is still under consideration, with every prospect of adoption.

Broughton Moor (Cumberland).—Messrs. R. Wilson and Sons, of Broughton Grange, the owners, have commenced to put down plant at their collieries with a view to the works being lighted by electricity. The necessary machinery has arrived, and it is proposed to light the engine-rooms on the surface and the underground main roads.

Wellington.—At a special meeting of the Urban District Council it was decided that the Council, having considered the tender of the Brush Electric Lighting Company for lighting the town by electricity, should have an interview with their engineer with the view to the possibility of lighting the town by electricity in 10 months' time.

Halifax.—The new infirmary and market to be opened this week has been fitted with electric light, bells, and telephones. The contractors for the work were Messrs. Ullathorne and Hartley, Halifax and Bradford, and Messrs S J. Waring and Son, Limited, Manchester ; and for the dynamo and engine, Messrs. Greenwood and Batley, Limited, secured the contract.

Newington (London).—The members of that alliterative body, the Society for the Promotion of Practical Progress, connected with Murphy Memorial Hall, Newington, have been discussing the introduction of the electric light into the parish. Alderman Hubbard, of the London County Council, addressed them, but they do not seem to have come to any resolution or decision.

Bournemouth.—At a meeting of the Town Council the Roads Committee stated that at their meeting a letter from the provincial superintendent of the National Telephone Company was read, enclosing plan of proposed underground works, and they (the committee) recommended the surveyor be instructed to report with fuller details than he has at present. The motion was adopted.

Paisley.—The Town Council, in committee, have selected the the following as a "short leet" for selection for the position of resident electrical engineer : Mr. Bell, Manchester ; Mr. Christie, Londonderry ; Mr. Cooper, Blackpool ; Mr. Pilling, Bolton ; Mr. Teague, Coatbridge ; Mr. Pender and Mr. Anderson, Paisley. The salary is £200, and 61 applications were sent in to the Council.

British Motor Syndicate, Limited.—An extraordinary general meeting of the shareholders of the British Motor Syndicate, Limited, has authorised an increase of the capital of the Company to £1,000,000 by the creation of 850,000 shares of £1 each, and confirmed the action of the directors in purchasing patents and altering the name of the Company to the British Motor Company, Limited.

Westminster.—The order for the electric lighting of the National Gallery of British Art, now being built on the site of the Millbank Prison by Mr. Tate, has been placed in the hands of Messrs. Drake and Gorham. Mr. C. N. Russell, whose agreement with the London and Lancashire Electric Company has terminated, has joined Messrs. Drake and Gorham's staff, and is personally supervising the work.

New Company.—The Morley Fletcher Wave-Power System, Limited, which was registered on July 4, with a capital of £20,000 in £10 shares, to enter into an agreement with B. M. Fletcher to acquire patents relating to a system for employing or utilising sea or other wave power, takes power to carry on the business of an electric light and power company in all its branches. Mr. Fletcher is to be chairman, managing director, and engineer of the company.

Harrogate.—At a special meeting of the Town Council the Electric Lighting Sub Committee reported that they had resolved on the requisition of not less than six owners or occupiers to lay mains for the purposes of general supply of electricity along any street or part of a street in the area of supply, but outside the compulsory area. A resolution was received from the Highways Committee complaining of the way in which the Electric Lighting Committee had laid the cables under the footpaths in the streets.

Devizes.—A special meeting of the Town Council has been held for the purpose of considering an application by Messrs. Brown and May, Limited, for a concession to enable them to supply electric lighting to customers in the town. After a lengthy discussion, a resolution was unanimously agreed to appointing a sub-committee to ascertain whether there was likely to be any demand for electric lighting, and to recommend to the Council the advisability of considering the supply of the same, whether by contract or otherwise.

Wells (Somerset).—The town clerk has reported that the Royal assent had been given to the Act confirming the provisional order for lighting the city by electricity, and that in accordance with the resolution of the Council he was now about to instruct Dr. Hopkinson and the city surveyor to proceed with the preparation of plans and estimates, in order that as soon as the Act was published he might be able to apply to the Local Government Board and the Board of Trade for the necessary sanctions for loans and approval of system.

Blackpool.—The electric light has been installed at the Empire the current being generated on the premises. The plant has been fixed in the basement, and consists of a 25-h p. gas-engine and a non-magnetic dynamo, capable of supplying 750 16-c.p. lights, with a consumption of 900ft. of gas per hour. The National Gas Engine Company, Ashton under-Lyme, are responsible for the machinery, which has been running for several days to mutual satisfaction. There was a temporary failure of the town electric light in Bank Hey-street last Saturday.

Bromley.—Mr. Craig, highway surveyor for the district, reported at the meeting of the Rural District Council in regard to the application of the National Telephone Company to erect tele-

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phone poles along the side of the highway from Keston Park to Holwood House, that at places the road was already too narrow for the ever-increasing traffic, and that the poles should be kept at least 4ft. outside the water-tables, which could not be done unless the poles were set in the bank. The matter was adjourned for consideration by the highway authority the following week.

Kirkby Lonsdale.—The electric lighting of Mr. Harris's house at Lunefield has just been completed. It is a seven-kilowatt plant, but is noticeable as the motive power is derived from the Mill Brow Beck. The dynamo is fitted with special carbon brushes and self-oiling bearings, in order to reduce attention to a minimum whilst running. The speed is 1,280 revolutions per minute. The current is carried a about a quarter of a mile to the house. The power-house was formerly a flour mill. A considerable fall has been obtainable, and a Gilkes' turbine has been put in to drive the dynamo.

Edison and Swan United.—The directors of the Edison and Swan United Electric Light Company, Limited, have determined to recommend the payment of a dividend in respect of the six months ended June 30 at the rate of 5 per cent. per annum on the "A" share capital of the Company, as now paid up, carrying forward about £5,000 as against £3,700 in the previous year, which together with the interim dividend at the same rate already paid in February in respect of the first half-year, will be equal to a dividend of 5 per cent. for the entire year. The dividend warrants will be posted on August 12.

Merthy Tydfil.—The Lords' Select Committee of the House of Lords on electric lighting provisional orders have considered the Bill promoted by the Corporation for powers to light their district by means of electricity. Mr. Lewis Coward, Q.C., appeared for the promoters, and Mr. Williams for the Merthy Tydfil Gas Company, who presented a petition to be heard on certain clauses of the Bill. Mr. Coward urged that the gas company had no *locus standi*, as the ground of their opposition was competition. Their Lordships decided that the gas company had no *locus standi*, and passed the preamble of the Bill.

Portsmouth.—The *Cambrian* (Swansea), in discussing the local tramway scheme, says: "There cannot be the slightest doubt about the success of the Portsmouth Corporation's electric light station. In a letter dated July 10, 1896, the chairman of the Electric Lighting Committee, Mr. Ellis, writes: 'You will doubtless be surprised to know that our output is now so great that we shall have to discontinue taking more consumers until we can get another engine, which is to be of 1,000 h.p.'" It is further added that the Portsmouth Corporation are now making enquiries in Swansea as to tramway working

Putz and Co.—The first meeting of creditors of the firm of F. J. Pütz and Co, chemical and general merchants, at 16 and 17, Great St. Helen's, E.C., has been held. One branch of the business was the purchase and sale of incandescent gas lamps and fittings. An action was, however, commenced by the Incandescent Gaslight Company, Limited, for an injunction against the debtor (the firm is now Mrs. Pütz) to restrain her from manufacturing and dealing in the lamps and accessories, which was granted, and the debtor attributed her insolvency to the action and inability to recover debts due. Mr. Ernest Cooper was appointed trustee of the estate.

Taunton.—At the Town Council meeting the Electric Lighting Committee reported that two boys broke a globe and otherwise damaged a lamp, and the committee had accepted £2, the cost of making good the damage. The committee, however, asked the Council to authorise them in the future to take proceedings against offenders. On the report, Alderman Spiller said he had noticed in the Press that at a Local Government Board enquiry held at Ealing, the cost of the installation of the electric light in various towns was produced. He was glad to see that the cost of the installation in Taunton was the lowest among all the towns where installations had been made.

River Plate.—Under the title of the River Plate Electric Light and Traction Company, Limited, a company has been registered by Ashurst, Morris, Crisp, and Co., with a capital of £300 000 in £5 shares, in order to adopt and carry into effect an agreement with the River Plate Electricity Company, Limited; to carry on the business of supplying electric light and motive power in the Argentine Republic, Uruguay, Paraguay, Chili, Bolivia, Brazil, or any other Republic or State in South America, or elsewhere; as contractors for the construction of rail and tram roads with electrical or other mechanical power. The registered office is 78, Coleman street, E.C.

Coolgardie.—The secretary of Westralia, Limited, has intimated to the shareholders that a company was promoted by Westralia Limited, to acquire and work a concession obtained from the municipality of Coolgardie for the lighting by electricity of that town. The directors now state that the lighting of the town was initiated on June 6 by the Mayor of Coolgardie, in the presence of the members of the Town Council. Further plant is under tender from firms in England, and it is confidently expected that when this is erected the lighting company will have entered the dividend earning stage. Westralia, Limited, holds a very large proportion of the capital of the lighting company.

Kidderminster.—The Select Committee of which the Duke of Westminster is chairman has had before it the Bill for a provisional order, promoted by a private company, for power to construct a tramway, to be worked by animal power or electricity, between Kidderminster and Stourport. The Bill had been before the Commons Committee, which, after 14 days' hearing, on the opposition chiefly of the Great Western Railway Company, who own certain branch lines in the district, found the preamble proved. Mr. Lewis Coward, Q.C., appeared for the promoters; and Mr. Pollock, Q.C., for the Great Western Railway Company. Ultimately, after hearing the evidence, the committee found the preamble proved.

Wolverhampton.—At a meeting of the Town Council a discussion took place upon the electric lighting works and their extension. One speaker said that with the exception of Manchester no town had made a profit during its first year's working of the electric light, while many towns had suffered heavily. Bristol during its first year's experience, incurred a loss of £4,090 and £2,509 in its second year; while Burton, Worcester, Dewsbury, and Bradford had also lost substantial sums as the result of the first 12 months' working. The loss in Wolverhampton was only £241 during that term, which was considered satisfactory. Some of the councillors, speaking from their own experience as manufacturers using the electric light, said it was cheaper and better than gas.

London County Council.—The Council's Committee have sanctioned an application made on behalf of the National Telephone Company for permission to lay two cables along the whole of the Garrick-street subway, as shown on a plan submitted with the application. It was further reported that the work at the electric meter testing station in connection with the registration of meters tested, and of the fees due, had fallen considerably into arrear owing to the increase of business at the station. So that there may be no undue delay in obtaining payment of the fees, and in order to overtake the arrears it is proposed that an additional clerk should be employed for three months at a salary not exceeding 30s. a week. The Establishment Committee are to select a man for the purpose.

Bury St. Edmunds.—The Town Council, after having adjourned the question for a month have now adopted the electric lighting scheme. Several of the members of the Town Council are interested in the local gas company, and the town clerk (Mr. C. Salmon) had given his advice that they might nevertheless vote on the point. However on the opening of the discussion, Alderman Lake, who supported the scheme, intimated that if they did so their action would be challenged. Alderman Floyd said the directors of the gas company had decided to abstain. This made the matter a foregone conclusion, and the report of the committee recommending the scheme was carried most of the known opponents of it taking no part in the division. It will be remembered that the proposal is to light the whole of the streets with incandescent lamps, but to supply private lighting in a restricted area only There are to be four arc lamps. Mr. Medhurst is the engineer.

Edinburgh.—At a meeting of the Electric Lighting Committee of the Town Council it was resolved to recommend the Magistrates and Council to accept an estimate for additions and alterations at the central electric lighting station, Dewar-place, amounting to between £4 000 and £5,000. The question of the proposed depreciation or reserve fund in connection with the electric lighting undertaking of Edinburgh has also been under consideration of the Electric Lighting Committee Prof. Kennedy, the Corporation's consulting engineer, attended the conference. With the exception of the treasurer, the meeting, it appears, was practically unanimous in favour of the establishment of a fund of some sort for renewal of perishable parts of the undertaking. The treasurer, on the contrary, is stated to have given expression to the view that there was no reason for establishing a depreciation or reserve fund, and that the whole electric lighting surplus of this and future years should go to the relief of the rates.

Appointments Vacant.—The Cape Town and Suburban Electric Lighting Company, Limited, invite applications from qualified engineers for the office of electrical engineer to manage the electric lighting of the company, and to carry out any new constructive work which may be required. The commencing salary is £300, and first-class passage will be paid to colony. Applications, stating age, qualifications, and experience, with copies only of testimonials, should reach Messrs. Davis and Soper, London agents, 54, St. Mary axe, E.C., from whom all further particulars may be obtained, not later than 31st inst.—The Rochdale Corporation want a working engineer to take charge of precipitation-tanks, sludge pressing machinery, and electric lighting plant at the sewage-disposal works, Rochdale. Wages, £2. 5s. per week. Application to Mr. S S. Platt, borough surveyor, Rochdale.—The Plymouth Corporation want an assistant to the borough electrical engineer. The salary is £150, and particulars are obtainable from the town clerk.

Charing Cross and Strand Corporation.—The directors of the Charing Cross and Strand Electricity Supply Corporation, Limited, have invited subscriptions for an issue of 10,000 4½ per cent. preference shares of £5 each at par. The prospectus states that the net profits for the half year ending June were £10,181, which were derived from the supply of electrical energy within the parish of St. Martin's in-the Fields. In order to meet the outlay for the erection of the station and machinery at 85, Commercial-road, as also for the laying of mains in the Strand district and for other purposes, the directors have taken powers to increase the authorised debenture issue from £100,000 to £150,000, and to issue £100,000 of preference shares. The sum of £50,000 is now required, and a further issue of preference shares will be made as and when the necessity arises. The list closed on Thursday. The directors have declared an interim dividend for the half-year at the rate of 5 per cent. per annum on the ordinary shares carrying forward £6,100, after payment of all interest on debentures.

Liverpool.—At a meeting of the Lighting Committee of the Corporation, Councillor Petrie presiding, Mr. Bellamy, gas inspector and superintendent of street-lighting, presented a report

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respecting the lighting of the plateau in front of St. George's Hall and a portion of Lime-street in the immediate vicinity. He detailed the existing lighting arrangements, and suggested the substitution of the electric light for the majority of the present gas lamps. The committee adopted the report, and decided to recommend the Council to carry out the scheme. At the half-yearly meeting of the shareholders of the Liverpool Tramways and Omnibus Company, on Saturday, Sir David Radcliffe, the chairman, said the Corporation had approached the directors with a view to ascertaining whether, if some efficient means of mechanical traction were proposed by them, the company would be prepared to consider the working of it. The directors had expressed their readiness to move with the times in the matter of mechanical haulage, and wanted to adopt something which would not only do their work well, but which would also look well and be a credit to the city of Liverpool. A new overhead railway station at the Herculaneum Dock has been opened.

Chiswick.—A Local Government Board enquiry has been held with reference to the erection of a chimney shaft at a cost of £650. Mr. Ramsden explained that two years ago the Chiswick Local Board leased to the Bourne and Grant Electric Lighting Company, Limited, a piece of land on which to erect a lighting station for the supply of the electric light to the whole parish. The lease was for 42 years, with the option to the Council of purchasing the company's rights at the end of 21 years. The company submitted to the District Council plans on which the shaft was shown, and the Council then approached the company with the view of securing that the shaft to be erected should be of sufficient capacity to be utilised for the purposes of a dust destructor. The foundations of the lighting station had been already put in, but the whole of the works had been stopped pending the sanction of the Duke of Devonshire to the erection of a dust destructor. That sanction had now been obtained, and the plans had been modified by the Council to show a shaft enlarged in diameter and increased in height, from 60ft to 150ft. The saving which it was estimated would be effected by the erection of the enlarged shaft was £1,000.

Birmingham.—A meeting of the shareholders of the Birmingham Central Tramways Company, Limited, has been held to consider an agreement between the directors and Messrs. William Mackenzie and James Ross, representing a syndicate for the transfer of the business of the company for a consideration equal to par value of the debentures and preference shares of the company, and a sum of £6 for each £5 ordinary share, with interest at 5 per cent up to the completion of the purchase ; and a further proposition that, for the purpose of this sale, the present company be wound up. The assent of the Board of Trade and the Birmingham City Council as the lessors of the lines to renewed leases have been obtained, and as an inducement to the consent of the Corporation the syndicate have made several important concessions, among them the abolition of steam and the general adoption of electricity as a motive power. The syndicate propose to form a new company, with a nominal capital of a million and a quarter sterling—the capital of the present company was originally £650 000, but the ordinary shares were written down half from 1894, bringing the total to a little under half a million sterling—and to take over all the liabilities and assets of the existing company. The purchase money is £485,000. The purchase was agreed to unanimously

Cardiff.—At a meeting of the Lighting and Electrical Committee, Mr. N. Appelbee, manager of the electric lighting works, presented a report showing that the total number of 8 c.p lamps connected up to June 30 was 12,642, as compared with 4,992 in the corresponding period of 1895, being an increase of 7,650 Total Board of Trade units generated for the month of June 16,558, calculated revenue for the same—public arcs, £78 ; private supply (approximate), £195. 17s. 1d. ; total (approximate), £273. 17s. 1d. ; revenue for the corresponding month of last year, £141. 16s. 6d. ; calculated increase, £152. 0s. 7d. Mr. N. Appelbee further reported upon the breakdown and cessation of the electric lighting on the night of the Royal visit on Saturday, the 27th ult. He said that at the time the two triple-expansion engines were running separately on the load, being one on each of the two mains which supply the town. Each engine was developing about three-quarters of its full power. At about 10 p.m it was found that the big end of the intermediate rod of No. 2 engine had become heated, and as it could not be kept under the engine was shut down, and its load put on No 1 engine, which was thereby somewhat overloaded After a short time this engine also warmed up and had to be shut down to ease the bolts on one rod, thereby causing a total extinction. The cause of the whole affair was due to the heating-up of the first engine—*i.e.*, No. 2—which might possibly have been avoided by more care on the part of the greaser who was tending it.

City of London.—The Streets Committee have been inspecting the experimental electric lighting of the side streets of the City. First of all they dined together and presented a testimonial to Mr. Berridge, the late chairman and then proceeded to Wood-street to make an inspection of the experimental lighting in that thoroughfare and in the adjacent side streets. It proved a very interesting survey, and the result of the committee's deliberations on the question will be submitted in the shape of a report to the Commission of Sewers. The whole length of Wood-street between Cheapside and Cripplegate-buildings is lighted by gas lamps. In Watling-street, Old Change, Friday-street, Bread-street, and Bow-lane the lamps are arc and incandescent electric lights. Eleven arc lamps light Watling-street, Old Change, Friday-street, and Bread-street. They are supplied with energy from the alternating private supply circuits, and each lamp takes about 250 watts, or half as much as the power taken by a lamp in the main streets. In Watling-street, Old-change, and Bread-street the lamps are suspended above the centre of the carriageway from girders or rods fixed to the houses. In Friday-street, for the sake of comparison, the lamps are fixed on brackets Bow-lane is lighted by incandescent lamps fixed on five brackets. They are supplied with energy from the alternating private supply circuits, and take about 200 watts each, except the three lamps fixed on one bracket, which together take about 200 watts. At the Cannon-street end of Bow-lane three lamps have been fixed instead of one, with a view to determine whether improvement in distribution can be thereby obtained.

Leeds.—The British Thomson-Houston Electric Company have given notice to the Corporation that after the 31st of the present month they will cease to run their present service of electric cars on the Roundhay-road. This decision of the company appears to have been somewhat hastened by the letting of the tenders by the Corporation for the proposed new service of electric cars from Roundhay to Kirkstall. Mr. Hannam, the chairman of the Highways Committee, believes that in six months the alterations in the permanent way from Roundhay to Kirkstall, rendered necessary by the adoption of the new system, will be completed, and he sees no reason why, in eight or nine months from now, electric trams should not be able to run from Kirkstall Abbey to Roundhay Park. The construction of the works for the overhead electric traction system has just been commenced. At the new entrance to Roundhay Park in Prince's avenue the central line of a double track of tramway has been laid out, and the chairman of the Highways Committee formally started the work of digging for the foundation of the new track. The total length of the track work for the whole route is seven miles, for, although some 6½ miles of track is already laid, all of this will have to be taken up either for renewal or rearrangement as to gauge, etc. The whole of the contracts for the electrical part of the work are required to be completed within six months, and as in the nature of things the tracks must be the first portion of the work completed, the committee have divided this work into such a number of contracts that most of the paving and flagging contractors of the city have a share of it, and it is contemplated that all of this part of the work will thus be completed within the next four months. With a view to minimising the interference with the street traffic it has been arranged that the work in the crowded part of the city shall be proceeded with night and day.

Brighton.—The report presented by the Electricity Lighting Committee at the meeting of the Corporation stated that for the purpose of equalising the distribution of pressure it would be necessary, before next winter, to run inter connecting mains in certain streets, the total cost of which was estimated by the borough electrical engineer (Mr. Wright) at £860. He estimated that the profit on the supply of electricity to the gas lamps in these new streets would be £23 per annum As this inter-connecting from the side streets would certainly improve the pressure, and at the same time give the inhabitants opportunities for taking a supply of electricity, he trusted the committee would sanction this work being put in hand, for which the money was borrowed at the last enquiry The committee approved of Mr. Wright's proposal, and recommended that the public lamps along the line of such new mains be lighted by electricity instead of gas. The adoption of the proceedings was proposed by Councillor Stafford and carried. In his financial statement the chairman of the Finance Committee of the Shoreham Harbour Trustees (Mr. Sundius Smith) said that the importation of coal by the Brighton Gas Company to June 30 last was 41 560 tons as against 43 074 tons for the year ending June, 1895 The exceptional weather in the two periods was well known, but the effect of electric light was, perhaps, not so well known. From the returns of the Brighton Corporation and the Hove Electric Lighting Company to the Board of Trade, they sold an amount of electric current equal to one hundred million cubic feet of gas during the year 1895. This meant that had this not been so, some 10,000 tons more coal would have been required for gas manufacture, the whole of which would have entered Shoreham Harbour, and would have contributed to their revenue. Probably if the Trustees had enquired, they might have obtained the actual coal consumption at the generating stations, which would have been more to the point.

Oldham.—Lord Derby has given notice that he will in the House of Lords move a number of amendments to the Tramways Provisional Orders (No. 2) Bill, in which the Oldham, Ashton-under-Lyne, and Hyde district order is included. In Clause 6 his Lordship suggests that an alteration should be made to the effect that no junction should be constructed with the tramways of the borough of Oldham. For the protection of the Manchester Carriage and Tramways Company, he proposes to add to Clause 14 words to provide that the promoters shall not commence the construction of any part of the tramway No. 7 where the same shall be within 18in. of or between the rails of the tramways of the Manchester company at the said point of crossing until one month after notice has been given, the notice to be accompanied by particulars of the proposed works. If before the end of the month or of 48 hours (in the case of repairs) the Manchester company give notice that they desire themselves to execute the works of construction, maintenance, or repair, the Manchester company shall be empowered to do so. A new section provides that the promoters shall keep all posts, wires, and apparatus within 20 yards of the tramways of the Manchester company in good condition, and by another section the promoters are to work the traffic on tramway No. 7 (an electric line) where it crosses the tramways of the Manchester company so as not to impede the traffic upon the tramways of the latter company, and no vehicle on tramway No. 7 shall be permitted to approach within 10 yards of the crossing at any time when any vehicle of the Manchester company is

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approaching the crossing and is within 30 yards thereof. A further section proposes that the promoters shall so construct and maintain the electric mains, wires, etc., as not to interfere or impede the tramways of the Manchester company and so as not to interfere with or affect the adoption by the Manchester company of electricity or other mechanical power as a motive power upon their tramways, and any overhead wires erected or used by the promoters under the powers of this order shall be at least 20ft. above the level of the tramways of the Manchester company at the said point of crossing. The promoters shall also be responsible for all damages by reason of any default or omission of the promoters.

Aberdeen.—Correspondence from the National Telephone Company was submitted at the meeting of the Finance Committee intimating the company's receipt of the committee's proposal to charge for each telephone pole erected in the city. The company stated that they declined to take any notice of the charge until the question of their request for the Council to lay pipes for the conveyance of the wires underground was settled. The committee unanimously decided to refuse the company's application as to the laying of the pipes. The work of fitting up the electric light in the Advocates' Library has now been completed by Messrs. Shirras, Laing, and Co.'s engineers In all 132 lamps have been fitted up. The current is drawn from the Corporation main, and is regulated by an Edison-Swan distribution board. A joint meeting of the Gas Sub-Committee of the Town Council and the Docks and Pilotage Sub-Committee of the Harbour Board has been held for the purpose of considering the question of introducing electric lighting at the quays. Discussion took place as to which part of the scheme would fall to be carried out by the Harbour Commissioners, and what part the Council would do. It was decided that the Commissioners should provide the necessary standards for the lamps, and superintend the lamps after they are erected. The Town Council, on their part, would supply the current and lay the mains It was remitted to Mr. Nicol, harbour engineer, and Mr. Blackman, electrical engineer, to bring up a report as to the type of mains that should be laid, on what part of the quays they should be constructed, and as to whether it would be necessary to put down two sets of mains—one for lighting and another to convey motive power for dock gates bridges, cranes, etc The meeting was unanimously of opinion that if electric lighting was to be adopted the installation should be of the most complete kind. The Corporation, in view of the additional plant they are laying down, will be able to supply any quantity of current; and it is expected that a considerable revenue will be derived from supplying light to vessels discharging cargo by night and for driving cranes on the quays. As to the price to be charged for the current, consideration of that was deferred until the Gas and Electric Lighting Committee have received a report on the subject from the engineer.

Warminster.—At the meeting of the Urban District Council a letter was read from the Board of Trade asking whether the electric light was still in vogue in the town, and if not whether the cable had been removed. The Chairman said that in reference to the matter they were to have a visit from Mr Mark Hill that day and they would let it remain over till then. Subsequently Mr. Hill came, and after some discussion on the subject of sewage asked whether the Council intended to pay him the money they owed him for the electric light? After a lot of persuading he was induced to allow a cable to be attached to his dynamo. Eventually he allowed it to run at the ridiculously low sum of £15 a year for the one lamp, conditionally that if more lamps were put up he should light them, and that he could continue his cable to light any business houses that required it. All this time he was losing £1 a week on the transaction. Subsequently he got a promise that something should be done. A meeting was held and it was decided to erect more lamps. They came to him and asked what he would light them at, and he gave a price. He went, on the strength of that, to considerable additional expense, including the purchase of another dynamo and cable. Before that could be completed the Smallbrook Mill scheme turned up and they threw him over. He wrote several letters, and finally he was told the Council had Smallbrook Mill, and did not want him. He could not keep on losing money, and he wrote to them accordingly. By and bye, he was compelled to switch the light off Then when he applied to put up other lamps he was told he would do so at his own peril. He sent in a reasonable bill for £50, and they offered him £12 10s., which he did not accept. Someone might say he ought to have kept on and finished his contract, but no one would have done that under the circumstances without some chance of getting his money back. Mr. Hill withdrew, and subsequently, after further discussion on sewage, Dr Alcock asked who it was made the promises to Mr. Hill. The Clerk said the only thing was a certain agreement was made with Mr. Hill to light the one lamp, this being terminable by notice, which was duly given, and expired last March. Ultimately, Mr. Chambers proposed that the Council adhere to the offer made to Mr. Hill in January, 1895 (namely, £12. 10s.). Dr. Alcock seconded, and this was carried. Nothing appears to have been settled as to the reply to the Board of Trade's letter.

Yarmouth—The Electric Lighting Committee reported that since the last meeting applications had been received from five customers for 222 lamps, the total number now being 177 customers or 8,365 lamps. The expenditure for June was £123. 8s. 2d., and the income from all sources £111. 18s. 8d, showing the cost of working over income to be £11. 9s. 6d. In addition to this, there is about £100 for interest, repayment of capital, etc., the actual deficit thus being £111. 9s. 6d. The borough surveyor, in his half-yearly report, submitted that the steadily-increasing demand would soon convert the loss into a gain. The difference between income and expenditure for 1895 was £766, £420 of which provided for the sinking fund. This was 75 per cent below the estimated loss. The income for the present year to date was £1 082, and the expenditure £817, leaving £265 for sinking fund, etc., and as this was estimated at £600 there was a net loss on the six months of £335. The interest charges would be increased next half-year, and would probably amount to £800, but it was hoped that this would be met by an increased income. The money earned in the first half of 1895 was £570, and in the latter half £1 370, whilst that for the half year just ended was £539 more than in the corresponding period last year, the working expenses being only £155 in advance, which latter was largely due to the continuous running through the day. The surveyor estimated that the loss for the whole of the present year would not exceed £400, and as 10,000 lights would be installed by that time, it might be anticipated that in 1897 there would be no loss to fall upon the rates. Mr. Preece being present when the report was given, stated that, after fully considering the financial position of the electricity supply works, he considered there was no cause for alarm as to the ultimate success of the undertaking from the fact that during the summer months no profit was being made. He advised that, wherever it could be done, encouragement should be given to customers to extend the hours during which the current was in use, and that special facilities should be given for the use of motors during the hours of daylight. As stated in the borough surveyor's report, the average earning per lamp wired up last year was 7s. 4d. As 9s. was the average earning of its equivalent in gas, this must be expected to be increased, and that the costs of working last year, which was 3·17d. per unit generated, would most certainly be reduced, and he hoped during the present year to see it reduced to 2½d. The public lighting last year had not been remunerative, but he hoped, as costs of working were lowered, to see this pay its way at the prices now charged. He considered that the present method of apportioning the sum to be paid for the public lamps each month according to the number of hours alight was not a proper one, as the cleaning, fixing carbons, interest, and capital charges were the same throughout the year. He produced tables of curves which had been prepared by Mr. Rankin, showing the lamp connections each month, the income derived from public and private lighting, and the expenditure, and from a study of these curves, and from what he knew of the works, he considered that the present charge of 6d. per unit would be remunerative, and that the prospects of the undertaking were most hopeful, and that as soon as possible it would be highly desirable, in the interests of the Corporation, to reduce the charges to persons taking current during the hours when a light load only was being sent out from the works, and he considered that 4d. per unit would be a remunerative charge. He further stated that for tramways and works of a similar character the current from the Corporation works could be profitably employed. The Borough Surveyor said that several of the proprietors of stalls in the market were willing to lay on the light. The cost would be about £15 for cable and £5 per customer for meter pit. The committee instructed him to ascertain the number of customers willing to come on, and the amount they were willing to guarantee as a minimum quantity for a year's supply, and also the proportion they were willing to pay towards the cost of building the meter pits.

London Extensions—The committee of the London County Council have received and sanctioned notices from the Metropolitan Electric Supply Company of intention to lay mains in Exeter-street, Burleigh-street, Tavistock-street, Southampton-street, Maiden-lane, Covent-garden, Bedford-street, New-street, Bedfordbury, Garrick-street Charing Cross-road, Shaftesbury-avenue, Rose-street Hart-street, James-street, Bear-street, Cranbourne street and alley, Leicester-place, Lisle-street, Little Newport-street, Gerrard-street, Macclesfield-street, Nassau-street, Hayes-court, Dean-street, Meard's-court, Frith street, Greek-street, Church-street, Old, New and Little Compton streets, Queen-street, Richmond-buildings, Carlisle-street, Charles-street, Rathbone-place, Hanway-street, Sutton-street, George-yard, Rose-street, Moor-street, Lichfield-street, West-street, Lumber-court, Tower-street Great and Little Earl streets Dudley-street, Great and Little White Lion streets, Stacey-street, Phœnix-street, Lloyd's-court, Denmark and Little Denmark streets, High-street, Arthur-street, Church-lane, George street, Bloomsbury-street, Broad-street, Great and Little St. Andrew streets, Seven-dials, Upper St. Martin's lane, Castle-street, Chapel-place, Mercer-street, Langley street and court, Queen street (St Giles), Short's-gardens, King-street, Endell-street, Brownlow-street, Hanover-street, Wilson street, Charles-street, Broker's-alley, Drury-lane, Museum-street, High Holborn, Coal yard, Smart's-buildings, Charles-street, Newton-street Cross-lane, King-street, Brewer-street, Parker-street, Great Wild-street, Stanhope street, Harford place, Brydges-street, York street, Wellington-street, Bow-street, Warwick-place, Grove End-road, Melina-place, Elm Tree-road, Hall-road, Circus-road, Garden-road, Hamilton terrace and gardens, Alma-street, Hill-road, Abbey road, place, and gardens, Violet-hill, Nugent-terrace, Abercorn place and mews, Marlborough-place, Edgware-road, Elgin road and avenue, Portsdown-road, Carlton road and hill, Lennard-place, Cavendish-road, Cavendish-road West, Wellington road and place, Eaton-terrace, High-street (Marylebone), Charles lane, Henry-street, Upper and Lower William streets, Barrow Hill-road, Chapel-street, Wilton-place, Charles-street, Park-road, Frederick-street, St. John's Wood road, Oak Tree-road, Lodge road and place, North and South Banks, and outer circle of Regent's Park, Marylebone-lane, Great Portland-street, and Euston-road. The work is to be completed in six months, or the sanction to expire. Some of the work is to be carried on continuously. Two notices have been

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sanctioned given by the Charing Cross and Strand Electricity Supply Corporation of intention to lay mains in the Strand, Surrey-street, Norfolk-street, Howard-street Arundel-street, Water-street, Milford-lane, Essex-street, The Approach, Catherine-street, Holywell-street, Wych-street, Blackmoor-street, Stanhope-street, Newcastle-street, Clare-street, Holles-street, Houghton-street, Clare-market, Portugal-street, Twining-street, Carey-street, Serle-street, Chancery-lane, Cursitor-street, Church-passage, Bream's-buildings, Clement's-inn, Hart-street, James-street Bow-street, Russell-street, York-street, Catherine-street, Tavistock-street, Wellington-street, Burleigh-street, Exeter-street, White Hart-street, across the Strand in two places, Chandos-street, Beaufort-buildings, Savoy-street, Southampton-street, Tavistock-court, and Covent Garden. The St. James and Pall Mall Electric Light Company has given notice of intention to lay mains in Regent-street, Piccadilly, Piccadilly-circus, Shaftesbury-avenue, Coventry-street, St. James's street and square, Pall-mall, Waterloo-place, Carnaby-street, Ganton-street, King street (Regent-street), Chapel-court, New Burlington-street, Savile row, Vigo-street, Ormond-yard, York-street, Jermyn street, Eagle-place, Mason's-yard, Duke-street, Ryder-street, Bury-street, Charles street, John-street, and King-street (St James's); and there was also a notice from the House-to-House Electric Light Company of intention to lay high and low tension mains in Lexham-gardens, and to construct three transformer-boxes. Both these notices were passed. Sanction was also given to a notice from the Vestry of St. Pancras of intention to lay mains in Camden-road and Cantelow's-road. The usual conditions are attached.

PROVISIONAL PATENTS, 1896.

JULY 13.

15447. A brush-holder to be used on dynamos and motors. George Edward Francis, Warren-lane, Chapeltown, Sheffield.

15479. Improvements in submarine cable-laying appliances. Charles Scott Snell, Culver Park, Saltash.

15517. Improvements in electric batteries. Rodolf Sauerwald and Henry Griine, 4, South-street, Finsbury, London.

JULY 14.

15534. Improvements in the construction of armoured insulating conduits. Alfred George Brookes, 55 Chancery-lane, London. (Russell Teel Elwell, United States).

15585. Improvements in and relating to writing telegraphs. Philip Arthur Newton, 6, Bream's-buildings, Chancery-lane, London (The Gray European Telautograph Company, United States.)

15595. An improved electricity meter for registering the amount of current consumed on direct or alternating polyphase, triphase, or quadruplephase circuits. Frederick John Beaumont and Frederick Hallows, 166, Fleet-street, London.

15606. Improvements in printing telegraphy. Joseph Joachim Reifgraber, 53, Chancery-lane, London.

15614. Improvements in electrical relays. Willoughby Statham Smith and William Puddicombe Granville, 24, Southampton-buildings, Chancery-lane, London.

15622. Improvements in alternators. Howard Blain Little, Norfolk House, Norfolk-street, London. (Complete specification.)

JULY 15.

15677. An improved electrical counter. John George Dixon, 70, Palace-chambers, Westminster.

15678. Method and apparatus for utilising the mechanism of existing windmills for generating and storing electricity. Frederick Gray, 106, Priory Park-road, Kilburn, London.

15696. Improvements in the manufacture of tubes by electro-deposition. Edward Casper, 4, South-street, Finsbury, London.

15704. Improvements connected with joint or like boxes and appliances or attachments to be used therewith for electric and like wires. Charles Newton Russell, 166, Fleet-street, London.

JULY 16.

15768. An improved electromagnetic brake for vehicles. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Union Elektricitäts-Gesellschaft, Germany.)

15777. Improvements in electrically-actuated vehicle wheels. Charles Théryc, 45, Southampton-buildings, Chancery-lane London. (Date applied for under Patents, etc, Act, 1883, Sec. 103, January 30, 1896, being date of application in France.)

15782. Improvements in or relating to electric railways. Archibald H. Brintnell and George Samuel Baker, 111, Hatton-garden, London.

JULY 17.

15834. Improvements relating to the electrolysis of soluble salts especially applicable for the production of chlorine. Antoine Joseph Outhenin-Chalandre, 111, Hatton-garden, London.

15856. A new or improved electric clock. Joseph Pallweber and Adolf Kolbe, 6, Lord-street, Liverpool,

15837. Improvements in electric apparatus for st iking a bell, bells, or the like, or producing other effects by means of and at a distance from a clock. Edward Robert Dale, 77, Chancery-lane, London.

JULY 18.

15966. Improvements in or relating to electric arc lamps. Henry Leitner, 31, Southampton-buildings, Chancery-lane, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1895.

10308. Locks and electric signalling apparatus for use in connection therewith. Defert.

12157. Electric lighting specially applicable for lighting vehicles. Berners and Griffin

15703. Electric cables. Hardingham. (Felten and Guilleaume.)

15863. Dynamo-electric or electro-dynamic machines. Statter.

15880. Electric accumulators. Jungner.

16700. Apparatus for supplying electrical energy to tramcars from underground conductors. Siemens Bros. and Co., Limited. (Siemens and Halske).

16701. Contact apparatus and appliances in connection therewith for facilitating the passing of tramcars over crossings and switches in electrical tramways with underground conductors. Siemens Bros. and Co., Limited. (Siemens and Halske).

16737. Electrical apparatus for extracting gold and silver from cyanide solutions. Pfleger.

23515. The manufacture of electric cables. Borel.

1896.

8380. Printing telegraph instruments. Merritt and Joy.

10608. Tumler electric switches. The Edison and Swan United Electric Light Company, Limited, and Proctor.

10816. Electric measuring instruments. Devonshire. (Thomson)

10846. Magnetically affecting the counter electromotive force of the voltaic arc of an electric arc lamp. Thomson. (Coffin.)

11232. Electric current conducting apparatus for electric railways. Stendebach and Linker

11471. Arc lamps for alternating-current circuits. Wise. (Fernald and Hubbell)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5¾-6¼
Brush Company, Ordinary	3	1-1¼
—— Non. Cum., 6 per cent. Pref.	2	1⅜-1⅝
—— 4½ per cent. Debenture Stock	100	112-115
Charing Cross and Strand	5	8¼-8¾
Chelsea Electricity Company	5	7¾-8¼
—— 4½ per cent. Debentures	100	114-116
City of London, Ordinary	10	14¾-15¼
—— 6 per cent. Cumulative Pref.	10	16½-17
—— 5 per cent. Debenture Stock	100	133-137
City and South London Railway, Consolidated Ordinary	100	45-47
—— 4 per cent. Debenture Stock	100	135-137
—— 5 per cent. Pref. Shares	10	4¾ 15¼
County of London and Brush Provincial Co., Ordinary	10	8¾-9¼
—— 6 per cent. Cum. Pref.	10	13¼-13¾ xd
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2¼
Edison and Swan United Ordinary	3	1¾-2¼
—— 4½ per cent. Debentures	100	103-106
Electric Construction, Limited	2	1⅜-1⅝
—— 7 per cent. Cumulative Pref.	2	2¾-3
Elmore's Copper Depositing	2	[illegible]
Elmore's Wire Company	2	[illegible]
W. T. Henley's Telegraph Works, Ordinary	10	17¾-18¼
—— 7 per cent. Preference	10	17½-18½
—— 4½ per cent. Debentures	100	109-113
House-to-House Company, Ordinary	5	4-4½
—— 7 per cent. Preference	5	8-8½
India Rubber and Gutta Percha Works	10	21-23 xd
—— 4½ per cent. Debentures	100	106-108
Isle of Man Electric Trams, Ordinary	1	1⅛-1⅜
—— 6 per cent. Preference	1	1⅛-1¼
Kensington and Knightsbridge Ordinary	5	9¼-9¾
—— 6 per cent. Pref.	5	7½-8
Liverpool Electric Supply, Ordinary	5	8-8½
Liverpool Overhead Railway	10	14-14½
—— 5 per cent. Pref.	10	17¼-17¾
—— 4 per cent. Mortgage Debentures of £100	100	112½-114½ xd
London Electric Supply	5	¾-1¼
Metropolitan Electric Supply	10	13½-14
—— 4½ per cent. First Mortgage Debenture Stock	100	119-123
National Telephone, Ordinary	5	7⅛-7⅜
—— 6 per cent. Cum. First Pref.	10	17-19
—— 6 per cent. Cum. Second Pref.	10	16-17
—— 5 per cent. Non. Cum. Third Pref.	5	6¾-7¼
—— 3½ per cent. Deb. Stock	100	107-110
Notting Hill Company	10	10¾-11¼
Oriental, Limited, £1 shares	1	1¾-2
—— £5 Shares	5	8¼-8¾
—— £4½ shares	4½	7¼-7¾
Oriental Telephone and Electric Company	1	½-¾
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	106-107
Southampton Electric Company	5	4¾-5¼
St. James's and Pall Mall, Ordinary	5	12-13
—— 7 per cent. Pref.	5	9½-10½
Telegraph Construction and Maintenance	12	37-40 xd
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary		8-8½
Westminster Electric Supply, Ordinary	5	11-12
Yorkshire House-to-House	5	7¼-7¾

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NOTES.

The New Anglo-German Cable.—The fourth Anglo-German cable was used for the first time on the 16th inst.

Institution of Electrical Engineers.—We have to acknowledge the receipt of the *Journal* of the Institution which completes the papers for last session. We may probably further notice its contents shortly.

Applied Chemistry.—The second International Congress of Applied Chemistry was opened on Monday at the Paris Sorbonne under the presidency of Mr. Berthelot, who in his presidential address referred briefly to the work done on metals with the electric furnace and to the possible influences of acetylene.

Telegrams to Hungary.—It is stated that during the International Telegraph Conference at Budapest an agreement was concluded between the British and Hungarian Telegraph Departments for the establishment of direct telegraphic connection between London and Budapest. Negotiations with that object had previously taken place, but without success.

Electric Light Race-Track.—It is stated that an electric light race-track has been laid out at Rosedale, near Cincinnati. The track is a third of a mile in circumference, and has 1,000 lights, with powerful reflectors. The "grand stand, fences, rails, and outbuildings are all painted a glistening white, so as to intensify the lighting." The effect may possibly be more curious than pleasing.

A Sensitive Relay.—Some time ago a method of making a relay more sensitive by adding a helical spring on each side of the armature was suggested in Australia by a Mr. MacDonald. It has now been claimed as a prior invention of Mr. D. B. Granby, of St. Louis, who, however, appears to have discarded it because he did not want it. Of course, it is an idea that is bound to get tried in more than one place.

Prizes.—Of the awards for 1896 of the French Société d'Encouragement, the Prix Melsens, for the author of an application of physics or chemistry to electricity, ballistics, or hygiene, has been awarded to Dr. Castaing for his work on ventilation. The prize of 2,000fr. for an incandescent lamp of 1 c.p., 100 volts, $\frac{1}{20}$ ampere has not been awarded, but an *encouragement* of 1,000fr. has been given to Messrs. Javaux and Nysten, and a similar sum to Mr. Solignac.

Earth Field.—The mean determination at Greenwich of the horizontal magnetic force with the Elliott instrument for 1895 in metrical units is stated as 1·8387. This is greater than the value given by the Gibson instrument by 0·0064. The difference is larger than in preceding years—viz., 0·0030—the increase of the difference being, no doubt, due to the permanent effect of the iron in the altazimuth building. The magnetic disturbances during the year 1895 were comparatively trifling.

Armature Losses.—According to an article in the *Elektrotechnische Zeitschrift* of July 23, Mr. O T. Blathy, of Budapest, states that he has discovered that there is a greater loss in armatures running on load than theory would indicate. From what we can gather from the limited details, this discovery is remarkable only because incorrect theories have been assumed. Every authority in England acknowledges that the Foucault loss increases with the load, and is not a constant, as assumed by Mr. Blathy.

A Spanish Installation.—The electric lighting of Carballino, in Spain, is the subject of a note in the *Revista Tecnologico-Industrial*. It is calculated on a base of 500 16-c.p. incandescent lamps and four arcs. The generating station is about a mile away from the town, and water power to the extent of about 100 h.p. is obtainable from the River Areuteiro, a 16ft. fall being available. The alternating-current system is adopted, with 2,000 volts on the transmission line and two transformers at the town. The construction has been done by Planas Flaquer and Co. for the concessionary, Don Ramon Laforet.

Paris Exhibition.—A deputation from the London and other Chambers of Commerce has waited upon the Under Secretary of State for Foreign Affairs, Sir Henry Bergne, K.C.B. (head of the Commercial Department of the Foreign Office), and Sir Courtenay Boyle, K.C.B. (permanent secretary of the Board of Trade), at the Foreign Office, on the subject of the arrangements for the forthcoming Paris International Exhibition. The deputation was introduced by Sir Albert Rollit, M.P. (president of the London Chamber of Commerce), and included Major S. Flood Page, Mr. Alex. Siemens, Sir Henry Doulton, and Sir Frederick Abel, K.C.B.

Lightning.—Some cricketers, or, perhaps, merely onlookers at a cricket match, had a narrow escape at Kirton Lindsey, in Lincolnshire, last week. If one of our provincial contemporaries is to be relied on, in Lincolnshire a match is not necessarily stopped even by what is described as a "terrific" thunderstorm. What it says is: "During the progress of a local cricket match a blinding flash of lightning knocked down three men named Holmes, Skinner, and Haydock. The former had his clothes ignited and lay unconscious. Skinner was seriously burnt, and Haydock sustained a severe shock. Others in the immediate vicinity felt the effects of the flash."

The Leeds Tramways.—The great sub-division of the contracts for this important work seems to have caused a good deal of misunderstanding. The divisional contracts for the overhead construction also included the bonding of the rail. This was first awarded to Messrs. Crompton and Co., but that company found that the latter part of the work had not been allowed for in their price, and hence withdrew. The next lowest price was that of Messrs. Siemens Bros. and Co., and now we hear that they, too, decline to undertake the work. We hope that someone will eventually take up the contract, but we understand that it is not a valuable one to dynamo builders.

Italian Thunderstorms.—In last week's issue of *L'Elettricità* no less than nine cases of damage or death from lightning are recorded as having taken place on the 18th or 19th inst. in North Italy. The list makes no pretence to be an exhaustive one, and it is highly improbable that this represents more than a percentage of the total mischief. At Solero, near Alessandria, one flash killed three people and seriously injured three more. An Italian ship at Fiume was struck at the same date, so that the storm must have been of very considerable extent. The crew received a severe shock and were mostly stunned. Alongside the ship struck was another loaded with powder, but fortunately this vessel escaped.

Wonders of Electricity.—A Dalziel telegram from San Francisco, which has been printed by several papers that ought to have known better, reports that Mr. Frank Close, of Oakland, California, has invented "a contrivance for seeing through a wire by an adaptation of the principle by which the telephone is worked, with an apparently similar transmitter and receiver. Attached to the latter is a piece of tourmaline, through which a person looks and sees what is happening at the other end of the wire." The reason of writing this note is simply in order that if any of our readers should come across a reference to the "telectroscope"—the design of the name is strictly on a par with the invention—they will know what that word means.

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Lamp Economy.—In a paper read before the Canadian Electrical Association, and reprinted in the *Canadian Engineer*, Mr. P. G. Gossler remarks on the subject of the most economical voltage at which to run incandescent lamps—*i.e.*, whether or not to over-run them and put up with the short life. His standard is apparently a 50-volt lamp, which seems curious to us nowadays in England. This, however, does not affect the argument, which results in the conclusion that it depends, among other things, on the question whether the lamps are run at a time of maximum current output or not. Naturally, it would be so, but then the customer who pays at so much per unit for his current will not trouble to consider that. It is his own pocket that concerns him.

New Technical Journal.—We have received copies of the *American Electrician*, a new electrical monthly which has incorporated *Electrical Industries*, and is to succeed that paper. The care which is devoted in America to the appearance and general turn-out of a technical journal has always been noteworthy, and in this respect the new comer can hold its own with the best. One point is the placing of the contents in readably large type on the front page of the unobtrusively coloured wrapper. This is apparently to be sacred ground, from which the advertiser is rigidly excluded. The contributors include some well-known names, but at present we have not had time for a detailed investigation of the contents of the three numbers of our new contemporary now before us. It should be added that the publishing office is 1,315, Havemayer-building, New York.

The Telephone Girl.—The telephone girl is heard by many and seen by few, and some people when they hear her do not appear to be satisfied. She has, however, been put on the stage, and her counterfeit presentment is to be seen nightly at the Theatre Metropole at Camberwell. To those who do not know or are content to ignore the actual working of a switchboard the position of the operator has obvious dramatic possibilities, and hence we have the English adaptation of "La Demoiselle du Téléphone," which was played some time ago with considerable success in Paris. For the English edition the late Sir Augustus Harris and Messrs. F. C. Burnand and A. Sturgess are responsible. The plot, of course, turns on a telephone girl in the execution of her duties overhearing her lover making an appointment with a music-hall "artiste."

Tramways Institute.—The annual meeting of the Tramways Institute of Great Britain and Ireland takes place to-day (Friday), at the Holborn Restaurant. After the election of officers for the year and the appointment of the quarterly meetings for the session, the following papers will be taken: "Mechanics of Horse Haulage," Mr. T. H. Brigg; "Improvements in Horse Haulage Equipment," Mr. W. H. Sleep; "Mail Horseshoes," Mr. F. C. Miller; "Westmoreland Car Starter and Brake," Mr. W. Westmoreland; "Rawling's Patent Car Starter and Brake," Mr. John Rawlings, C.E.; "Mechanical Traction," Mr. J. Sturgeon; "Patent Reliance Check," Mr. J. H. Betteley; "The Brand Electric Railway System," Mr. Franklyn; "Signal Bells and Self-Acting Rain-Proof Seats," Mr. C. Challinger. The dinner takes place the same evening at the Holborn Restaurant.

The City of London Accident.—At the adjourned inquest on the death of Chisholme at the City of London Electric Lighting Company's station at Crosby-square, nothing more of importance was brought out. Tillbrook, the attendant at the St. James's-square sub-station, was called, and denied that he ever did anything to make any of the mains "alive." He merely visited the sub-stations to take readings of the supply of electricity to customers, as well as to see that the switches were in order, and to feel the secondary connections to see whether they had become warm or not. The jury then wandered off into the question of whether the company paid their workmen an ideal rate of wages, and ultimately returned a verdict of accidental death, adding various recommendations and opinions which, if they had been founded on expert evidence or a knowledge of the subject, might have been of value.

Self.—Several French writers on electrical subjects have recently got into a really very funny way of using the English word "self"—at least, it looks so to an Englishman. For instance, in the course of an elementary explanation of the phenomena of alternating currents by means of the hydraulic analogy, *L'Etincelle Electrique* speaks of "un circuit electrique à self et capacité," and similar expressions are constantly being met with. Of course, it all arises from taking over the English expression "self-induction" and then dropping the latter part of it without considering what the result may be on the meaning of the remainder of the compound. The French have a right to do as they choose with their own language, and the English language will not be hurt by one of its words being used wrongly abroad. But it seems a needless sort of barbarism among writers who are usually far more careful of their style than we care to be on this side of the Channel.

Current for Montreal.—It is stated that the Lachine Rapids of the Canadian St. Lawrence are to be utilised as a source of power. For some time work has been prosecuted on a large wing dam that runs out for more than a thousand feet into the St. Lawrence River. A fall of water is secured by means of a dam sufficient to develop at the low-water season about 15,000 h.p. This water power is to be transformed into electric current. Upon the dam a power-house will be built that will run its entire length and show an unbroken interior of 1,000ft. in length. The basement of this will be occupied by Stilwell and Bierce waterwheels. The main floor will contain the dynamos, of which there will be 12, each of 1,000 h.p., or 12,000 h.p. in all. They will generate current for transmission to Montreal, for use there in lighting the city, operating the street railroads, and for any and all other lighting and power purposes.

Water Power.—People are always talking about utilising water power, but if anyone does it they are more discontented than before. An anonymous "Tourist" has written a long letter to the *Daily Chronicle* objecting to the Duke of Fife lighting his new house electrically, because he (the tourist) fears that it may result in there sometimes being a little less water to come down the Linn of Corrymulzie The pretension of the townsman that anyone in the country must do nothing with his own property that interferes with the tripper's idea of what looks rural or romantic when he happens to take his holiday, is getting just a little extravagant. What would "Tourist" say if the Duke of Fife objected to an alteration of "Tourist's" shop or office on the ground that he came along the street once a year and did not think it would look quite so well as before, and, further, insisted on a right to interfere as to the water supply of the fountain in "Tourist's" villa garden.

Sparks Wanted.—In the old days, when the "music of the future" had not become the music of the present, or, to be more accurate, a rather small part of it, a great deal of fuss used to be made about the scenery and effects in connection with the Wagnerian operas at Bayreuth. It is to be regretted that the traditional—though, even then, not unquestioned perfection—does not seem to have been

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maintained, and, from our point of view, still more regrettable that the electrical department appears to have been in fault. From this cause, at the last performance of "Siegfried" at Bayreuth, when the magic sword was being forged no sparks were obtainable. The smithy fire also misbehaved. But then in the old days they left the dragon, who is an important performer, without his head, this part of him having got sent to Beirout, in Turkey, instead of Bayreuth, by mistake of the forwarders. So, after all, things might have been worse without violating precedent.

Personal.—Mr. Joseph Laffargue has received from the French Government the honorary distinction of promotion to the rank of officer of public instruction. Mr. Laffargue is known in connection with our esteemed contemporary, *L'Industrie Electrique*.—The Executive Committee of the City and Guilds of London Institute have appointed Mr. W. E. Dalby, since 1891 university demonstrator of mechanism and applied mechanics at Cambridge, to the professorship of mechanics and applied mathematics at the institute's technical college, Finsbury, rendered vacant by the resignation of Prof. Perry. Mr. Dalby served a seven years' apprenticeship in the locomotive works of the Great Eastern Railway, and gained a Whitworth Scholarship in 1883. In 1884 he entered the service of the London and North-Western Railway; graduated B.Sc. (London) in 1890, and in 1894 received the full degree of M.A. *honoris causâ* from the University of Cambridge.

New Arc Lamp. — In Koerting and Mathiesen's alternate-current shunt arc lamp, instead of employing the usual attraction of a magnet in its armature for striking and regulating the arc, the inventors make use of the inductive repulsion of the rings placed in front of the poles of an alternate-current magnet. For this purpose there is employed a horseshoe electromagnet, having a core and coils, the ends of the core rising above the induction rings. A full description would be unintelligible without detailed drawings, but it is claimed for the principle involved that the "magnet with inductive repulsion" has an advantage over magnets with armature attraction, in that the position of the armature is without influence on the coefficient of self-induction of the shunt coils, and hence the lamp potential remains unaffected by the position of the armature. From the mechanical standpoint another advantage is claimed in the absence of a regulating spring, since alternating-current lamps are continually subjected to vibrations which gradually cause the weakening of the spring.

Cable Interruptions.—According to the official list published in the Berne *Journal Télégraphique* of July 25, up to that date the interruptions already noted of the Puerto Plata and Martinique cable and the Amazon Company's line beyond Monte Alegre still continued, as did the communications with Bissao and Bolama, and the Cartagena and Barranquilla lines in Colombia (New Grenada). In South Africa communication between Charter, Salisbury, and Beira, broken on the 9th, was restored the next day, but the Salisbury and Umtali line was interrupted almost immediately (on the 11th), and has not been restored. The Lourenço-Marquez (Delagoa Bay) and Durban cable was not working between the 13th and 25th. The Cadiz and Teneriffe cable was repaired on the 16th, after being interrupted since June 6, and the Jamaica and Colon (Aspinwall) cable, interrupted on June 10, was restored on July 3. The Pará and Maranhao cable was restored on the 16th after a week's interruption. The Shanghai and Nagasaki cable, which failed on the 23rd, was unavailable at the time the list was compiled. Some short interruptions of the Siberian land lines, now repaired, and a general breakdown in Ecuador on the 24th complete the list.

Rontgen Radiations.—It is stated that Messrs. Novak and Sulc have examined nearly 300 substances with a view to ascertain the absorption of the Röntgen rays by chemical compounds. Their method of investigation consisted in attaching rings of glass to a sheet of paper and placing uniform layers of the finely-pulverised materials in the different rings so that the thickness of the layer was 0·4cm. in each case. The paper with the rings was then placed over a photographic plate, which was enveloped in black paper and exposed to the Röntgen rays for a period of 20 to 25 minutes. By comparing the photographic effect of the rays where the substances were interposed, the relative absorptions were determined. A great number of organic compounds containing only carbon, hydrogen, oxygen, and nitrogen appear equally penetrable, and hence it is concluded that the absorption has no relation to molecular weight or the arrangement of the atoms. Organic halogen derivatives have been found to possess much greater absorption, which increased with the number of halogen atoms present. This effect increased with the atomic weights of the halogens, two atoms of bromine having a greater effect than six chlorine atoms, while iodine derivatives were entirely impenetrable under the conditions used in the experiments.

International Catalogue of Scientific Literature.—The international conference under the auspices of the Royal Society has been in every way a success from a scientific point of view, there being a general unanimity on all the questions decided. The new catalogue is to begin with 1900, is to be in English, and is to relate to "pure" science only, applied science being excluded; but the limits are to be decided hereafter. In indexing according to subject-matter regard is to be had not only to the title of a paper or book, but also to the nature of the contents. Moreover, the catalogue is to comprise all published original contributions to the branches of science indexed, whether appearing in periodicals or in the publications of societies or as independent pamphlets, memoirs, or books. The final editing and publication of such a catalogue is to be entrusted to a central international bureau acting under the direction of an international council, which will be responsible for the administration of the enterprise. Any country, however, which shall declare its willingness to undertake the task is to be entrusted with the duty of collecting, provisionally classifying, and transmitting to the central office, in accordance with rules laid down by the international council, all the entries belonging to its scientific literature. The central bureau is to be in London.

The St. Louis Tornado.—The following is from the *Street Railway Review* (Chicago): "A *Review* editor dropped into the luxurious office of Robert Andrews, vice-president of the Pintsch system of gas lighting in New York, as that gentleman was reading a letter from his St. Louis agent, in which was related the details of the great storm. One incident was especially remarkable and particularly interested Mr. Andrews, who was general superintendent of the Wabash railroad in 1872, when a big tornado swept East St. Louis. The railroad lost its round house and other buildings and hundreds of cars, and one 32-ton locomotive was hurled 20ft. from its tracks and thrown into a ditch. But this was not a circumstance to what happened in the recent storm as related in the letter. It seems the Brownell Car Company had just completed 10 very handsome cars for Columbus, O., in which, among other good things, were the Pintsch lights. These cars were loaded on flat cars, and would have left East St. Louis at 6.30 p.m. At 5.30

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the storm broke in all its fury and six of the ten were badly wrecked. Three escaped unscratched, and one was lifted bodily into the air, trucks and all, turned completely over, and landed on the same flat car within a foot of the space it had been resting on a moment before. This car suffered comparatively little damage although the globes of the gas lamps were shattered. As Mr. Andrews remarked, it was one of those cyclone phenomena which could only happen once in a thousand times."

Excursion to Switzerland.—In connection with the Institution of Electrical Engineers arrangements have been made for a students' excursion to Switzerland. The party of students and their friends will leave London on the evening of Saturday, August 29, and arrive at Bâle on the following evening. It is proposed to spend one day at Bâle, one at Schaffhausen, three at Zurich, one at Lucerne, and three at Geneva. The party will probably leave Switzerland on Wednesday, September 9, but arrangements can be made for any who wish to extend their visit beyond that date, as the railway tickets are available for 25 days. Arrangements can also be made to return by steamboat down the Rhine, which would take about two days, and would cost about £2. 10s. extra. Students who are already in Switzerland can join the party at Bâle. Mr. Webb is endeavouring to obtain permission for the students to inspect a number of the most important electrical works and installations in Switzerland, including the following: the Maschinenfabrik Oerlikon, Messrs. Brown, Boveri, and Co.'s works, the wire-rope and electric power transmissions at Schaffhausen, the Stanserhorn and Mont Salève Electric Mountain Railways, Messrs. Escher, Wyss, and Co.'s turbine works, the two great water-power plants at Geneva, and the Geneva Exhibition. There are still a few vacancies in the party, and applications from those desiring to join should be made without delay to Mr. G. C. Allingham, hon. secretary, Students' Committee, at Eldon House, Lyndhurst-road, Hampstead, N.W. The cost of the excursion is expected to be about £12.

Poor Arcs.—In a paper read before the National Electric Association of New York, and reprinted in the *Electrical Journal*, Mr. H. L. Rogers, of Cleveland, expresses great dissatisfaction with the arc lamp as at present manufactured. Mr. Rogers says: "Let us examine the arc lamp hanging in our streets. We find a device 50in. to 60in. long, made of long tubes or chimneys, a sheet-iron drum, long side rods, and at the bottom a globe-holder. We can see Davy's two pieces of charcoal; one is 12in. long and the other 6in. The rate of consumption has not changed. We realise that the useful length of this lamp is the vertical length of the carbons. Dividing 18in. by 50in., we find that the useful length of this device is only 36 per cent. of its total length. The statement may be made by some enthusiastic observer that there are two pairs of carbons, one pair alongside the other; but he must not forget that with our improved eyesight in 1896 we can look clear through the device and see not only the skeleton, but the marrow in the bones. These carbons are fastened firmly in their respective holders, and the holders are rigid. The burning of the arc causes the carbons to point up quite decidedly. When the current is shut off momentarily, these points fall together, and it very often happens slip by each other and wedge. When the current is again sent through the coil, its lifting power is not sufficient to pull the carbons apart, the lamp is rendered utterly useless, the policeman reports it out, and a deduction is made from the bill of the lighting company to the city. To prevent these deductions, amounting to more than the original bill, a corps of patrolmen are engaged, whose business it is to watch the lamps all night long, to prevent them going out, as a nurse would watch a sick child." We did not think it was quite so bad as this; but doubtless Mr. Rogers knows what they do in America, and what style of papers they like at the National Electric Association. The drift of the sentence referring to the Röntgen rays we simply do not understand.

The Telephone Service.—At a meeting of the council of the Leeds Incorporated Chamber of Commerce on Wednesday the secretary (Mr. Calvert) read some correspondence with the Postmaster-General with respect to a proposed modification of the rule governing the duration of trunk telephone calls in such a way as to enable a second period of three minutes' conversation to be obtained without notice having been given beforehand. The Postmaster-General pointed out that the rule was framed with the object of securing regularity and certainty in the working of the trunk lines and the proper regulation of the traffic, and said he feared that if it were abandoned inconvenience would be caused to persons waiting to use the trunk circuit by the unexpected extension of time which it would be in the power of those in possession of the circuit to claim. In reply to a further letter, the Postmaster-General maintained his former contention, but stated that the efficient working of the trunk telephone lines was a matter which was engaging his earnest attention, Mr. Zossenheim said that, as a rule, two minutes were occupied in getting into communication with the person with whom they desired to speak, and the result was that they had barely commenced their conversation when they were disconnected. Mr. G. R. Portway moved that they should intimate that the reply to their representations was unsatisfactory, and that through the Leeds members they should bring parliamentary pressure to bear in order to bring about a change. Mr. Zossenheim seconded this, and Alderman Lupton went so far as to say that he really felt that the Post Office was trying to make it as difficult as possible to use the telephone. The resolution was carried. Without going so far as Alderman Lupton, these constant complaints made by business men who know what they are talking about, and many of whom are acquainted with the facilities afforded in America and abroad, show that something must be wrong somewhere in the spirit in which the work of supplying telephonic facilities is approached by the only people who are legally allowed to undertake it.

Geneva Exhibition.—The official programme of the excursion designed to cover visits to the principal electric installations in Switzerland covers a period of six days from Monday, August 10. The excursion will start from Geneva on Monday morning at seven o'clock. The works visited will be Lausanne (tramways), Freiburg lighting (150-volt continuous), the Jura Simplon Railway (accumulator train-lighting). The night is to be passed at Neuchâtel. On Tuesday the works visited are the Val de Travers water power, 750 h.p. (65 amperes at 7,200 volts), the Combe-Garrot generating station, supplying Chaux de Fonds and le Locle, another series system of 3,200 h.p. with an 150 ampere current at 14,400 volts; and, lastly, the Neuchâtel town works, with single and tri-phase currents (1,500 h.p. and 4,000 volts), leaving for Berne in the evening. On Wednesday, after visiting the municipal installation at Berne (continuous at 110 volts), the excursionists leave for Langenthal and inspect the Wynau works (2,000 h.p., triphase current), finishing the day at Aarau. On Thursday the Aarau works are seen (two-phase and continuous); and the excursionists then go to Bremgarten and inspect the Zufikon works supplying current to factories at Zurich

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(1,500 h.p. and three-phase current at 5,000 volts). The day is finished at Lucerne, where the Thorenberg station (alternating current) is visited. On Friday there is an excursion on the Lake of the Four Cantons, followed by a trip up the Stanserhorn by the funicular railway. The Rathausen station is visited (two-phase current), and the night is spent at Zurich. Saturday, the last day of the excursion, is devoted to Zurich and its surroundings, including the Oerlikon and Baden works. The programme is signed by Mr. A. Palaz, the president of the Swiss Association of Electricians. The price of tickets is fixed at from 130fr. to 140fr. (£5. 12s.), according to the number joining. In order to arrange for lodging and means of transport it is essential that application should be made to Messrs. Ruffieux and Ruchonnet at Lausanne, with a deposit of £1 (25fr.) before 10 o'clock on August 8. Excursionists will travel second-class by railway and usually by special train. Accommodation will be provided at good hotels, but single bedrooms are not guaranteed. Ten francs extra (8s.) is required for this. A light breakfast, lunch, and dinner will be taken together. If the whole excursion is not taken, a rebate will be allowed on the scale of 10fr. a day. Arrangements will be made for forwarding a reasonable quantity of luggage. The excursion is, of course, designed in connection with the Electrical Congress at Geneva, which it immediately succeeds.

Tramcar Fenders.—The number of patents that have been taken out in the United States for tramcar fenders is remarked on in the *Street Railway Journal.* These cover devices of all kinds, sizes, and degrees of practicability, and are of such number and variety that among street railway men a new fender has come to be regarded in somewhat the same light as a new car coupler by steam railroad managers. Just how many fenders have been put on the market it is impossible to say, but a good idea of the large number can be obtained from the following incident: Some time ago a street railway manager stated in an interview, which was published in one of the daily papers of his city, that his company was on the look-out for a good fender. The interview was copied by a good many papers throughout the country, and within three months, it is said, 4,000 different fenders were offered him. The manager, in self-defence, was finally obliged to put up a notice on his doors, "No more fenders wanted." While the subject has its humorous side, and while many, if not most, of the devices are utterly absurd in conception and construction, the fact that so much attention has been given to fenders by the general public shows that there is a universal feeling that safety guards of some kind are necessary for electric cars in cities. At first this idea was not generally accepted by street railway managers, and quite a number still believe that fenders are not only not necessary, but often harmful. On the other hand, it is undeniable that they are being adopted in most of the large cities as well as in many of the smaller towns, and our contemporary thinks that all managers operating cars in crowded streets will do well, even if not believing that fenders are of much positive value, to disarm possible popular criticism by the employment of a safety device of the latest and most approved pattern. Another interesting and somewhat remarkable fact in connection with fenders is that, in spite of the enormous number of the fenders patented, but a comparatively small number of types have been adopted to any considerable extent. This might be understood in the case cited of a steam railroad coupler where uniformity of equipment is desirable, but with fenders a different type could be used on each road, or even on each car, without seriously affecting the efficiency of the service. Our contemporary argues that the fact that only about half a dozen types are in use shows that these do all that is requisite. The conclusion does not follow either in strict logic or railway practice, which is sometimes a different thing. Moreover, there is a difference between what is strictly requisite and what is desirable or, at any rate, desired.

A Conduit Rail.—Of the invention of methods of taking current from a conductor in a conduit "closed" or "open" there is no end, nor is there likely to be during the reign of the overhead trolley system, since, however pretty a plan may look on paper, nothing but an actual trial over a considerable length of way in all weathers can prove any device to be really effective, and when the ideal system has been found it will be always open to assert that just as good results can be obtained at less expense. Mr. Charles Sill's plan, which has been patented in America, is to put the conductor inside the rails. The rails form a continuous iron box or square tube, and the collector enters by a slit on the inner vertical side. The following is substantially the description of it as given in the *Scientific American*: "Each rail contains a continuous longitudinal duct, in which is carried the conductor, and on the inner side of the rail is formed a recess, in which is carried a sectional trolley wire which is engaged by a trolley wheel, whose rod is adjustably mounted in a bracket attached to the under side of the car. The upper ends of the trolley rod are drawn together by the tension of a coil spring, and they terminate in wires which lead to the motor, the action of said spring serving to keep the trolley wheels in contact with the trolley wire. The conductor and the trolley wire are normally disconnected, and they are automatically connected as the car passes along the track. This is done by means of a contact making and breaking device, which is adjusted in the inner web of the rail and consists of two rods, one of which carries the conductor and the other the trolley wire, said rods being normally held apart by the tension of a rubber spring. These rods are carefully insulated from the rail, which carries them, so that only upon their being brought into contact with one another by the pressure of the trolley wheel as it passes can any circuit be formed between the conductor and the trolley wire. The transversely extending rod which carries the trolley wire is slidably supported at the upper end of a vertical rod which is carried by the base of the rail, and carefully insulated therefrom. The whole of the insulation is carried out with great care, and the construction is such that all moisture is excluded from the conductor and leakage prevented. The trolley rod is hung pivotally on the upper arm of the above-mentioned bracket, and has a rocking motion transversely to the car, in a slot in the lower arm of said bracket. The trolley rod is joined by a connecting rod to a crank disc, secured on a shaft extending longitudinally to the car, which is connected at each end by bevel gear wheels with the controller shaft on each platform. By turning the controller in one direction, the crank discs operate to press the trolley-rod wheels against the trolley wire, and thus push its carrying rods into electrical contact with the carrying rods of the conductor within the rail duct, thereby forming a temporary circuit on that particular section of the track, during the passage of the car. A coil spring, engaging the trolley rod and the two carrying brackets allows sufficient vertical adjustment to meet the irregularity of the track or the passage of the car wheels over an obstruction." Thus the description in our contemporary. Immediately underneath the rail may be the best place for the conduit or may not, but to mix conduit and rail up together in this way seems likely to be productive of any amount of difficulty. The name of the contrivance is the "duct trolley rail."

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THE 1896 MEETING OF THE VERBAND DEUTSCHER ELEKTROTECHNIKER IN BERLIN.

(BY OUR SPECIAL CORRESPONDENT.)

(Continued from page 65.)

The proceedings of Friday, June 19, concluded by an evening in "Cairo." The members of the society, including a goodly proportion of lady members and their friends, assembled in one of the largest restaurants in this exhibition. We then proceeded to walk through the streets of "Cairo," and to inspect the various attractions and scenic effects. The performance in the arena followed, and then the members gathered into the large room of the abovementioned restaurant. Presents were distributed amongst the ladies, and the evening's entertainment was finished by dancing.

Saturday, June 20.—The business was attacked with vigour on this morning, and, thanks to the generalship of the retiring president, Prof. Slaby, was easily concluded by 2 p.m. The programme was as follows:

1. Appointment of officers and council.
2. Selection of the place for the 1897 meeting.
3. Papers to be read and discussed: (*a*) Director Schwieger, on overhead and underground electric railways in large towns; (*b*) Prof. Heim, on a ballistic galvanometer unaffected by external influences; (*c*) Dr. Kaltman, electrician to the city of Berlin, on the effect of the electric problems of the future on municipal undertakings; (*d*) Dr. Görges, of Siemens and Halske, on variable-speed motors having revolving field.

The president elected for the present year was Mr. Stubben, of Cologne. The new council consists of Dr. Buddé, Prof. Slaby, Mr. Naglo, Mr. Jordan (of Bremen), and Mr. Jordan (of Berlin). The members of the larger committee of management were also slightly changed, and I was glad to see that Mr. Feldmann, of Cologne, was one of the new members elected.

The place fixed on for the 1897 meeting was Eisenach, a most picturesque little town in the centre of Germany. I understand that it was chosen so that the members could enjoy the surrounding country rather than for any engineering works to be seen in the district.

After the meeting was over a few gentlemen and I proceeded to the works of the Allgemeine Company to view a few high-tension experiments. The machine used was designed by Mr. Dobrowolsky, and generates current at the enormous pressure of 24,000 volts. The insulation on the coils is largely composed of mica, to enable them to stand this pressure. The experiments were not unlike those shown by Messrs. Siemens Bros. in this country, but the fact that the high pressure was generated direct in the coils, and not obtained by transforming up, formed their great distinction.

Interview with Von Dolivo-Dobrowolsky.

The subject on which I was most anxious to question Mr. Dobrowolsky was naturally that of polyphase work, of which he can justly claim an inventor's interest. The question of who may have been the first inventor by a few weeks, and whether the American were before the Continental experts, is one which in my opinion should be left to the historians to fight over. The real credit lies more in the fact that when the subject of our interview had discovered from his original researches the essential principles of the motor with a revolving magnetic field, he immediately put the same to practical ends. Since then the firm with which his name is so prominently connected has gone forward by leaps and bounds, and the advantages of this invention have been of service to the general public in hundreds of installations where the systems previously known would have been most inconvenient. It is also worthy of note that Mr. Dobrowolsky's patents are granted mostly for practical details and improvements now in general use. In these patents he acknowledges the prior work of Prof. Ferraris covering the first principles of the rotary field work. I found Mr. Dobrowolsky in his own office and very busy, but he kindly spared me a couple of hours of his most valuable time. He told me that the three-phase work could now claim the larger proportion of the total output of machines from the shops of the Allgemeine Elektricitäts - Gesellschaft. The total output of dynamos per annum now reaches the enormous aggregate of between 70,000 h.p. and 80,000 h.p., and their new works, which are referred to elsewhere, will enable the company to double this output easily. Some 20 machines of 1,000 h.p. and over were included in this large total. I next questioned Mr. Dobrowolsky on the vexed question of the drop of potential in three-phase work when used for lighting purposes. This effect has, he told me, been much exaggerated both abroad and in England, as with carefully-designed machines the fall of potential between no load and full load can be kept within 5 per cent. This, of course, is when incandescent lamps form the bulk of the load. He invariably uses the star method of coupling up the fields of the generators, and with the many and important installations carried out to his design has had no complaint of bad regulation. A very large plant is at present being laid down on this system at Oberspree, near Berlin, by the Allgemeine Company. The current will be generated at 6,000 volts between adjacent wires of the three-wire network, and then transmitted to the various suburban districts around the great city. The very best machinery will be used to ensure economy in working.

VON DOLIVO DOBROWOLSKY.

The engines will be triple expansion and condensing, the water supply for condensing purposes being ample. The coal supply can be drawn from any district as the prices may direct, and can be transported to the work either by the river or by one of the two railways which will have sidings to the works. The supply of power for manufacturing purposes is expected to provide the largest amount of load, although a large amount of lighting will be done. Mr. Dobrowolsky informed me that the charge for power would be 10pfg. ($1\frac{1}{4}$d.) and for light 50pfg. (6d.) per unit. With the lighting customers, however, good discounts will be given to regular consumers. The rate of discount will be based on the lamp hours by dividing the unit consumed by the maximum power required for the lamps. It is expected that a large number of electric tramways will be supplied from this station. The voltage of general distribution is fixed at 6,000 so that the fluctuations in pressure may be small. This pressure will be transformed down to 500 volts for motor work and to 120 volts for the supply of light. A low-tension distribution will is provided at these pressures as the demand arises. The magnitude of the district will be gathered from the scale map (Fig. 1). Current will be supplied at the start to the following places: Marienfelde, Britz, Lichterfelde, Spandau, Hohenschonhausen, Friedrichsfelde, Straulau, and Rudow. These places, shown by thick lines under the names, surround Berlin, so that a large mileage of mains will have to be laid. The mains to Spandau will be over 17 miles long, as a direct

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route cannot be taken. Other suburban towns will be connected as the undertaking progresses till a complete network has been established round the city. The company also hopes to supply a few sub-stations within the area of the town of Berlin, as the increased demand renders the present stations too small for their work. In that case, motor generators will be used to give the requisite continuous-current supply to the existing mains. Certain outlying portions of the town, not at present connected to these supply stations, may also be supplied from the beginning on the three-phase system. The magnitude of the undertaking, together with the economic consideration in the selection of the site and the type of machinery, should ensure a large remunerative load for the station when complete. The day load from the tramlines alone will be a most paying item in the revenue account. The buildings are being erected to contain machinery of 50,000 h.p., but the whole quantity of generating plant will not be installed at first.

I next questioned Mr. Dobrowolsky as to the type of alternate-current motor he would use for the rotary transformers. The advantages of the non-synchronous type, in his opinion, warrant its selection for this purpose. In efficiency, when loaded, there is nothing to choose between the two types—*i.e.*, synchronous and non-synchronous—but in the power factor the synchronous motor has its only advantage. A non-synchronous motor of large output will take some 10 to 15 per cent. more current for a given power than the synchronous one. This disadvantage is more than compensated, in Mr. Dobrowolsky's opinion, by the increased facilities in starting a non-synchronous motor; also, when running, the drive is much more flexible with the motor not running absolutely in step with the generator. There is a slight variation in speed if a sudden load comes on, which prevents undue strain. Again, with a synchronous motor a short-circuit may cause it to fall out of step, after which there is no recovering power, while a non-synchronous motor will always pick up its load again after the temporary short-circuit is removed.

The next point we conversed on was the advantage of the three-phase current for driving the machine tools in a workshop. Mr. Dobrowolsky's firm use this system entirely throughout their works, and carry the sub-division of driving power rather to an extreme. Even the grindstones have individual motors, but a number of small lathes are usually grouped on to one common countershaft driven by one motor. In comparing the three-phase with the direct-current system, Mr. Dobrowolsky assumed that some 200 motors were required in a particular case. That meant 200 commutators and at least 400 brushes. Assuming the motors were well designed and in good order to commence with, it is extremely unlikely that the good condition will continue. If one motor wears its brushes rather quickly, and is not attended to when required, undue wear of the commutator takes place. So it is likely that a few motors will require repairs on their commutators, and that the brushes will be an item to be considered in the annual cost of upkeep. With the three-phase motor all the advantages of the direct-current motor can be obtained, and that without the use of either a commutator or brushes. The construction of the moving parts is also mechanically stronger, and moisture on the squirrel-cage rotor does no harm. It is also comparatively an easy matter to make the field coils waterproof. After seeing the plant at work, I could not but admit that the case for the three-phase motor was proved.

We then tackled the question of starting torque and current, together with the various starting devices used for three-phase work. Mr. Dobrowolsky informed me that a small motor, when connected direct to the full pressure of the mains, would take four or five times the normal current, and give at the same time three or four times the normal torque. Such a large starting torque is seldom required, and hence, except when the motor is used for working lifts or cranes, or some equally heavy purpose, the current at the start can be reduced with advantage. If, however, the generators are large compared to the motors, there is no reason why the motors should not be started by connecting them direct to the mains. This course is adopted in the Allgemeine works for motors up to 5 h.p. For larger sizes the starting current can be kept down by using a transforming device when first switching in. Another method invented by Mr. Dobrowolsky in the early days of three-phase work is that of inserting resistances in the armature circuit. This can, by means of a governor, be automatically short-circuited when a given speed is attained. This method, however, does away with the simplicity of the squirrel-cage construction, as collecting rings are required, and hence is not much used for small motors. A better way is to change the connections of

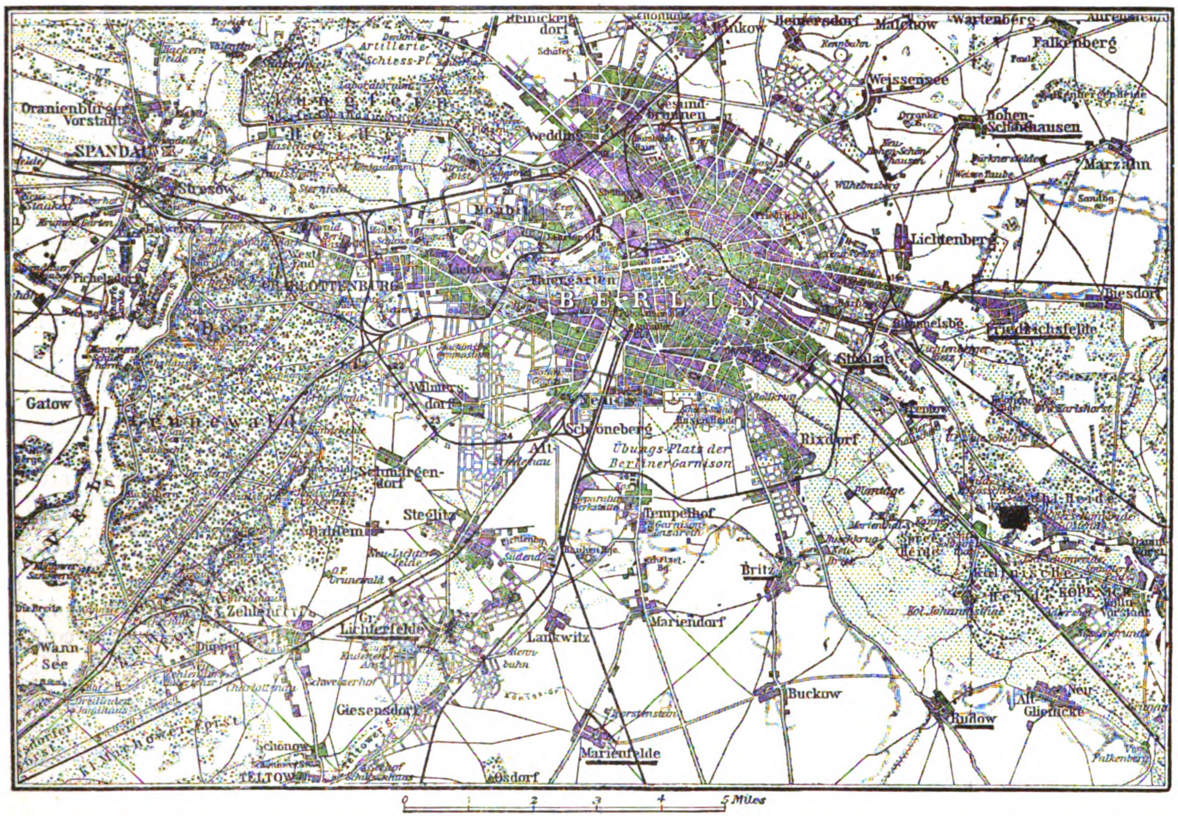

FIG. 1.—Map of the surroundings of Berlin, showing the district to be supplied from the Oberspree Station. ▬ denotes the station which will supply the places of which the names are underlined.

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the motor by a kind of series-parallel device. Thus, by a simple switching device, the connections of the motor can be changed from the triangle coupling to the star coupling when starting. When this is done, the motor, when connected direct to the supply, will give its normal torque with only 1½ times its normal current. The diagrams of connections (Figs. 2 and 3) illustrate this. Fig. 2 shows diagrammatically the connections used when starting, and which are changed to Fig. 3 as the motor gains speed.

If it is very important to prevent fluctuating, resistance is sometimes put in series with the motor. With very large motors, such as those required in sub-station work for converting alternate currents into continuous, it is preferable to put resistance in the induced circuit. The regulation is then effected on the low-pressure side, and on a large current, which is better than using resistance to be subjected to, say, 6,000 volts pressure. As a guide to

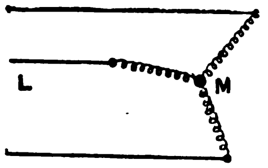

FIG. 2.—Starting Connections.

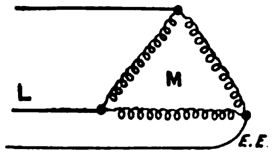

FIG. 3.—Working Connections.

what size motor can be used without starting gear, Mr. Dobrowolsky said that with a 300-h.p. generator a 10-h.p. motor can be switched directly on without disturbance to the surrounding light. The sudden drop then would be under 3 per cent. When using these motors for driving centrifugal apparatus for sugar refining, where a large mass has to be accelerated, care has to be taken that the motor does not take too much current during the time it is gaining speed. In such cases Mr. Dobrowolsky has found it better to design the motor to have more self-induction than usual, rather than to use starting resistances to be varied automatically or by hand. The regulation is then quite independent of the operations, and the motor brings the separator up to speed without straining anything. To show the power of these motors, one 4-h.p. motor in the works of the Allgemeine Company used to drive a wood-planing machine run at the high speed of 4,500 revolutions. When the wood is put to the revolving cutter it takes some 12 h.p., and yet the non-synchronous motor does not break down A high-frequency generator had to be used to drive the

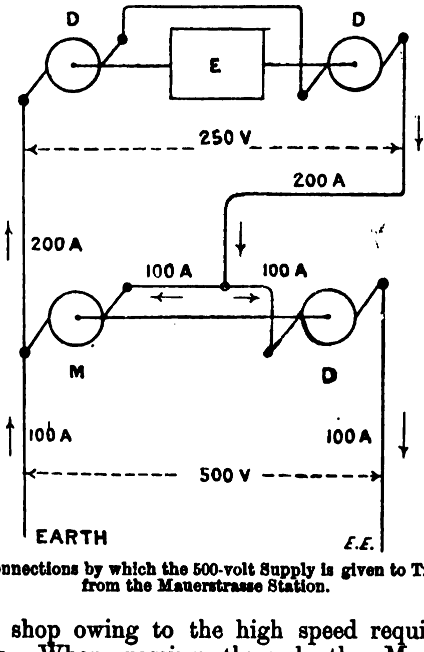

FIG. 4.—Connections by which the 500-volt Supply is given to Tramways from the Mauerstrasse Station.

carpenters' shop owing to the high speed required from the motors. When passing through the Mauerstrasse station of the Berlin electricity works the previous day I had noticed two of the large generators, coupled on either end of an engine shaft, to be running, although all the connecting rods were disconnected. As the Allgemeine Company have had most of this work through their hands, I asked Mr. Dobrowolsky the meaning of the above. He explained that most of the direct-current generators used in these works were wound to give 125 volts for the 110 volts supply on the main. The more recent additions are wound for 250 volts, so as to supply across the outside wires. The two machines I had noticed were these higher-voltage machines, and they were being used to supply 500 volts for traction purposes. The connections used are shown in Fig. 4. The main engine, E, of one coupled set drives the two dynamos, D D, at each end of the shaft. These are 125-volt machines and connected in series; they are used to supply the hitching-up motor generator, M D.

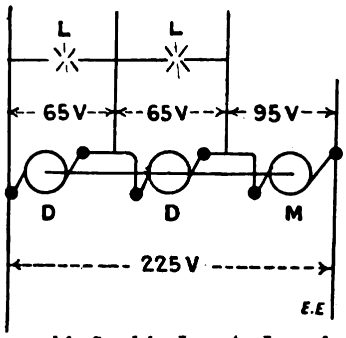

FIG. 5.—Connections used for Supplying Large Arc Lamps from 225-volt Supply.

These latter two machines are wound for 250 volts, and are mechanically connected to the engine crankshaft. The one acts as a motor and enables the other, as a generator, to hitch the voltage up to 500. The approximate distribution of current and voltage is shown. Mr. Dobrowolsky explained to me that by earthing the wire shown the insulation of the low-voltage dynamos was not strained. He also had used a similar arrangement for supplying large arc lamps from the two outside wires of the Berlin system. The connections used are shown in Fig. 5, and with them either lamp can be turned out without affecting the other. As a final subject I asked a few questions as to the conditions in town-lighting which determined the system. Mr. Dobrowolsky agreed that each place required separate consideration, but as a general guide said that for towns included in 1¼-mile circle he should always use continuous current if the station could be placed in the area. If the town was, say, three miles across, and the station outside the town, he should use a three-phase high-tension system. The transformer sub-station in such a case would be equipped with transformers of from 20 to 30 kilowatts. Strassburg has recently been equipped to his designs on the latter system.

EXPERT KNOWLEDGE IN AMERICA.

The New York State recently required an electrical expert to supervise, in the public interest, the equipment and running of electric railways. The various candidates were required to answer the following questions to show their knowledge of the subject:

1. State your age, education, and experience in the electrical business. Give details of positions held and duties performed, with time and place.
2. Give names of your present and former employers in electrical work, with addresses.
3. What type of electric generator is generally used in the electric railway power-house of to-day?
4. When more than one generator is used what practice is generally followed in their operation?
5. Give sketch showing connections of two railway generators when operating on the same circuit.
6. Give list of the protective and controlling devices on a railway generator switchboard, with sketch showing connections of same.
7. (*a*) What method would you employ in insulating generator base from foundation? (*b*) Why?
8. How would you quickly ascertain that the generator and switchboard operating devices were properly installed and insulated from ground while generator is in operation?
9. How would you ascertain if generator and switch-

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board operating devices are properly insulated from ground when generator is not in operation ?

10. What would be good practice in supporting, locating, and insulating wires from railway generators to outside circuits ?

11. Explain methods employed to build up a generator when it fails to generate when running at normal speed.

12. Give full description of your method of figuring the amount of copper necessary for an even distribution of power on a trolley system with 10 per cent. loss in lines.

13. What drop in potential does good practice allow in the rail and ground return ?

14. Complete the connection between the overhead supply circuit and the return circuit through the car, with list of articles employed therein.

15. What safety devices should a motorcar be equipped with electrically ?

16. What safety devices should a motorcar be equipped with mechanically ?

17. What is your opinion of speeds for electric cars in cities of the second and third classes ?

18. What is your opinion of fenders ?

19. What is a guard wire for electric street railways ?

20. What is your opinion of the utility of guard wires ?

21. (*a*) What is the cause of shocks being received from electric railway tracks ? (*b*) What is the remedy ?

22. Give length and type of car, in your opinion, best adapted for ordinary street railway practice in cities of 100,000 to 500,000 inhabitants.

23. (*a*) What, in your opinion, is the best method of returning the current on a horse-car road which is to be equipped electrically and is laid with flat rails on stringers, if such rails have an iron plate under each joint ? (*b*) If no plates are under joints ?

24. What direct-current potential would you consider dangerous to human life, and what in the case of the alternating current ?

25. Explain the electrolytic disintegration of underground metallic conduits by reason of leakages from railroad circuits. A complaint is made that a water-pipe in a street upon which there is a trolley road is suffering from electrolytic corrosion. How would you determine whether the alleged corrosion was partly or wholly caused by electrolysis, and how would you determine the length of time the pipe would last under such action, and what means would you suggest for its partial or complete prevention ? Should there be any communication between the rails and water or gas pipes, and, if so, at what point ?

26. To what would you connect the ground 'bus of the central station ? Would you advise positive or negative terminals of dynamos to be connected to ground, and give your reasons ?

27. What is meant by over-compounding, and what is its function in practice ?

28. Describe the chief functions of a series-parallel controller for street-car motors.

29. How does the fluctuating character of an electric railroad load affect the choice of engines as regards condensing and non-condensing ?

30. What factors determine the speed of a motor, and what factors determine its power ? Give complete details and formulæ.

ELECTRIC LIGHTING IN BELFAST.*

BY VICTOR A. H. MCCOWEN, ELECTRICAL ENGINEER TO THE BELFAST CORPORATION.

Belfast, like many other large centres, was slow to make advances towards the adoption of a system of electricity supply, the chief reason being that the Corporation preferred that others should experiment, and that they themselves should profit by the experience thus gained. The Belfast Corporation, being the owners of the gasworks, and justly proud of the reputation they had gained of having their thoroughfares well lighted by gas, and the undertaking being also a paying concern, had no intention of allowing private companies to occupy the field. No fewer than seven of the latter in 1882 served notice of their intention to apply for provisional orders for power to supply electricity within the city. All these applications were successfully opposed ; the Corporation remained in possession, and for seven years no further active steps were taken. During these seven years the output of gas had risen from 615 million cubic feet in 1882 to 907 million cubic feet in 1889, and absolute necessity was shown for the extension of the gasworks to cope with the enormously increased consumption. A great difficulty arose as to where a suitable site for that extension could be found. The Gas Committee were thus led to consider the question of the introduction of electric lighting. In September, 1889, they reported that in their opinion the time had arrived when the Council should obtain powers to supply electricity for lighting purposes, etc., within the city, and they also recommended that authority should be given to apply to the Board of Trade for a provisional order for that purpose. Application was duly made and granted, the necessary power being contained in the Belfast Electric Lighting Order, 1890, and by the Belfast Corporation Various Powers Act, 1890. The Gas Committee were authorised to pay £50,000 out of the surplus profits of the gas undertaking towards the establishment of the electric light. Mr. James Stelfox, engineer and manager of the gasworks, reported to his committee regarding the proposed extensions, that "it must remain with the committee to decide to what extent they would anticipate the success of the electric, or any other method of lighting, resulting in a decrease in the demand for gas. . . . . I believe that as yet the use of electricity in any place has never resulted in a lessened demand for gas, and I see no reason to believe that such a result is now probable." The Gas Committee subsequently reported to the Council that they had had under consideration the question of the introduction of lighting by electricity, and that, taking into account the importance of the matter, they recommended the Council to appoint a special committee to procure all the information requisite for the guidance of the Council thereon, and to draw up a report embodying the same. This committee was appointed, and, after visiting the principal electrical installations in and around London and the electrical exhibition at the Crystal Palace, reported in October, 1892, in favour of the establishment of an installation of 10,000 lamps of 8 c.p., with room for extension. It was next decided to obtain the assistance of a consulting engineer, and Prof. Alexander B. W. Kennedy, F.R.S., of London, was appointed. On account of the saving in capital cost, and other circumstances of the case, he recommended the system about to be described.

Area Supplied.—The area at present supplied with electricity in Belfast comprises probably the best part of the city. It includes first-class shops and offices, hotels, clubs, theatres, and churches ; and in Howard-street and College-square private houses. The following tables gives the percentage in lamps connected of different classes of consumers :

	Per cent.
Shops closing late	8·0
Shops closing early	30·0
Shops closing early, but late on Saturday night	25·0
	63·0
Offices	11 0
Hotels and clubs	6·0
Theatres	12·0
Churches	4·8
Private houses	2·0
Motors	1 2
Total	100·0

As shops and offices together form a large percentage of the total consumption, the shape of the load curves depend greatly on their hours of closing. The Saturday curve shows the effect of the late closing of some shops, a much better load being then given with no very objectionable peak. The distance of the farthest lamp from the station is as yet only about 800 yards, as the present area supplied with electricity is only a small part of the city. There is no doubt that when mains are laid in the residential districts the load curve will be greatly improved. A good motor day load is looked forward to in course of time, as there is no doubt respecting the several advantages of electric motors, more especially to small users of power, and where the power is used intermittently. Up to the present the question of street-lighting has not been considered.

Mode of Distribution.—The system of distribution is what is known as the three-wire low-tension. The current is supplied to consumers at 110 or 220 volts pressure. The distributing mains are connected up in a network, and fed at seven points by feeders from the generating station. The feeders deliver the current at the feeding points of the distributing mains at a pressure of 220 volts. The drop in the feeders at full load is 10 per cent. The pressure between the middle wire and the positive or negative is 110 volts. Pilot wires are connected from the feeding points to voltmeters in the generating station, so that the switchboard attendant can always see what the pressure is at these points, and keep it constant by due regulation.

* Paper read before the Institution of Mechanical Engineers at Belfast

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Charges and Pressures.—The charge for current for lighting is 7d. per Board of Trade unit, with discount ranging from 2½ to 17½ per cent. according to consumption; the maximum discount reduces the price to 5·77d. per unit. The charge for current for motors, heating, etc., in daylight hours is 4d. per unit with the above discounts, of which the maximum reduces the price to 3·3d. per unit. Meter rents range upwards from 2s. 6d. per quarter, according to size. Installations containing over 50 lamps of 8 c.p. are wired either with single 220-volt lamps, or with pairs of 110-volt lamps in series, or on the three-wire system. Motors of over 1 h.p. are supplied with current at 220 volts. The meters in use are those of the Ferranti type.

Station.—The generating station is situated between Chapel-lane and Marquis-street, within 250 yards of Castle-place, which is practically the centre of the city; it is therefore a good position from which to distribute the supply. In the selection of the site the question of convenience for delivery of coal, removal of refuse, etc., had not to be considered. The buildings were designed by Mr. C. Stanley Peach, of London. The shape of the site is rather irregular, and the space available has been made use of to the best advantage. The engine-room occupies the central and larger portion of the site, and measures 85ft. long by 33ft. wide at the east end and 44ft. at the west end. A six-ton overhead travelling crane is provided, all the motions of which are actuated from below by means of ropes. The switchboard platform is raised about 4ft. above the floor level, and runs the whole length of the west wall of the engine-room. The battery-room, measuring 28ft. square, is situated between the engine-room and the offices, on the same level. It contains four rows of stands for the cells, and is provided with ample means of ventilation. The offices occupy the west end of the site, with frontage to Marquis-street. The meter-testing room and storeroom are above the offices on the first floor. A fitting-shop and driver's room are placed at the east end of the building, and above them is the cooling tank, measuring 34½ft. by 12½ft. and 4ft. 2in. deep. Owing to the absence of anything like solid foundations to build upon, the whole site was piled with 480 piles of 35ft. length. A 3in. Memel flooring was secured to the pile heads, and on this was placed concrete to a depth varying from 3ft. to 4ft. to form the engine beds and the foundation for the walls of the building.

Engine-Room.—The plant in the engine-room consists of the following engines and dynamos: Four 120-i.h.p. tandem double-acting horizontal gas-engines, running at 160 revolutions per minute, and driving, through eight ⅞in. diameter cotton ropes, four 57·6-kilowatt dynamos of 240 amperes and 240 volts at a speed of 600 revolutions per minute. Two 60-i.h.p. single-cylinder double-acting horizontal gas-engines, running at 160 revolutions per minute and driving, through eight ⅞in. diameter cotton ropes, two 26·4-kilowatt dynamos at 750 revolutions per minute. Two 150-i.h.p. four-cylinder single-acting high-speed vertical gas-engines, running at 380 revolutions per minute, coupled direct to two 72-kilowatt dynamos of 300 amperes and 240 volts.

Switchboard.—The switchboard consists of five slates, each about 7ft. high; the centre one is 36in. wide and the others 32in. All are bolted to an iron framework, fixed on the switchboard platform about 4ft. from the engine-room wall. The centre slate carries the feeder and omnibus-bar voltmeters, the battery instruments and regulating gear, and the middle-wire ammeter and connections. The other four slates carry the feeder and dynamo instruments, switches, etc.; the two on the left hand are for the positive side of the system, and the two on the right hand for the negative side. The machine and feeder bars are fixed vertically on the front of the outer slates. Each is provided with three holes, through which a plug can be inserted to make connection with any one of the three omnibus bars that are fixed horizontally at the back of the board. The feeder bars are connected to the ammeters, to the switches, and to the fuses. From the feeder fuses to the point where they leave the station the feeders are brought in the form of bare solid copper rods supported on insulators, which are fixed behind the matchboarding at the south side of the engine-room. The machine bars are side by side with the feeder bars, and the connections to the machine ammeters and automatic switches are at the back. The leads from the dynamos consist of insulated cables, which are brought along behind the matchboarding at the north side of the building. The automatic switches are arranged to break circuit, should the current from the machine fall below 10 amperes. The shunt change-over switch is shown above the automatic, and connected with it by an interlocking lever. An ampere-hour meter is connected in the circuit of each dynamo, and registers the work done during a run, the readings being taken at start and finish. The voltmeters are Kelvin multicellular electrostatic, and are provided with multiple-contact switches. The feeder voltmeters show the pressure at any feeding point between the middle wire and the positive and negative wires. The bar voltmeters show the pressure between the positive and negative omnibus bars, and also between the middle wire and any of the omnibus bars. The dynamo voltmeters are used for showing the voltage of the machines before putting them on to the circuit. The batteries are connected through their ampere-hour meters, polarised ampere-meters, and emergency switches to the top omnibus bars. The usual practice at full load is to have all the machines and feeders plugged in parallel on this bar; but should it be necessary to run any particular pair of feeders at a different voltage, this can be done by plugging that pair of feeders and a machine on the bottom omnibus bar. As a matter of fact, it has never been required to run a separate machine on a separate pair of feeders, as a very even drop all round is obtained. The link connections in the circuits of the small machines are used for connecting them in the following different ways: (*a*) as balancing machines on either side of the system; (*b*) as a special charging circuit for the batteries; (*c*) in parallel with the large machines across the system. The starting resistances and the shunt resistances are fixed in the cellar beneath the switchboard. The shunt regulating switches are fixed on the handrail of the switchboard.

Battery.—The battery consists of 126 cells of the Electric Power and Storage Company's 34 K or heavy-discharge type—63 cells for the positive side of the system and 63 cells for the negative. The capacity of each cell is 500 ampere-hours, at a discharge rate of 100 amperes. The battery will, however, give a much higher rate of discharge for short periods. The plates are contained in lead boxes which are supported on wooden stands, being insulated from the latter by means of glass oil insulators. There are also eight hospital cells, which can either be used for assisting weak cells, or be put in series with the main battery. The connections from the battery to the regulator and switchboard consist of bare copper rods supported by oil insulators suspended from the roof. The method of regulating the battery is different from that usually practised by cutting in or cutting out end cells. The regulation here is accomplished by putting the cells at the middle-wire end of the positive battery in parallel with those at the middle-wire end of the negative battery; the other ends of the batteries being connected through ammeters and emergency switches to their respective omnibus bars. The regulator is placed in the battery-room, and is worked from a handwheel on the switchboard by means of a rack and pinion. A reversible ampere-hour meter, which registers both charge and discharge, is connected in each battery circuit.

Dynamos.—The dynamos are by Messrs. Siemens Bros., double-pole with drum armature and shunt-wound. The rope-driven machines are provided with heavy flywheels, and the larger ones have three bearings. The two small 26·4-kilowatt machines have double-wound armatures, each winding connected to a separate commutator. By means of a plug-board the armatures can be put in series or parallel, so that the machines can be run at 110 to 120 volts for balancing, or at 220 to 240 volts across the system. The voltage can also be increased to 270 if required. The rope-driven machines are placed close up to the back end of the back cylinder, to save floor space; and backward driving has been adopted, in order to get the slack of the ropes at top.

Gas-Engines.—The six horizontal gas-engines were manufactured by Messrs. Dick, Kerr, and Co., Kilmarnock, under Hartley and Kerr's system. The four larger are double-cylinder double-acting with the cylinders working tandem and the two pistons on the same rod, which is connected through cross-head and connecting-rod to the crank. The bore of the back cylinder is 13⅝in., and of the front 13½in.; the stroke is 20in. The flywheel and driving wheel, one fixed on each end of the crankshaft, are each 8ft. 5in. diameter, and weigh 37cwt. and 29cwt. respectively; the driving wheel is grooved for eight ⅞in. ropes. These engines run at a speed of 160 revolutions per minute and indicate 120 h.p.; the number of explosions per minute is 320, or two per revolution. The two smaller engines are single-cylinder double-acting; the cylinder is 13½in. diameter and 20in. stroke. They run at 160 revolutions per minute, and indicate 60 h.p. The number of explosions per minute is 160, or one per revolution. The flywheel and driving wheel are each 7ft. diameter, and each weighs 57cwt. The cyclical variation in the speed of the tandem engines is very small, owing to the number of explosions, their low initial pressure, and their even distribution, the number of explosions being as four to one in comparison with a single-cylinder single-acting engine. The impulses occur in the following order:

First, Front cylinder,	front end,	angle of	crank	0deg.
Second, ,,	,, back	,,	,,	180deg.
Third, Back	,, front	,,	,,	360deg.
Fourth, ,,	,, back	,,	,,	540deg.

There are thus four complete Otto cycles in two revolutions; and this working is continued right through the whole range of the engine load.

Governing.—The method of governing is different from that usually adopted of missing an explosion. With these engines the impulses are continuous, and are graduated according to the load. Sets of indicator diagrams taken from No. 6 tandem engine at several different loads, from 20 per cent. overload down to only dynamo excited, all ends working right through,

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showed that no explosions were being missed. In the single-cylinder engines the same even distribution of work done is not obtained, and heavier flywheels have therefore been provided. With the tandem engines it is at once seen that very steady working may be attained without running at a high speed. These engines were originally intended to work down to one-third of full load without missing an explosion; and it was thought that at lighter loads an explosion might be missed and still sufficient steadiness be maintained. It was found, however, that the missing of an explosion at light loads affected the steadiness too much; and the adjustment of the engines was then taken in hand under the immediate personal supervision of Mr. Hartley, with the result of obtaining finely-graduated impulses, such as the writer believes have previously been unknown in gas-engines. The engines are now capable of working from 20 per cent. overload down to no load without missing an explosion. In diagrams taken when the engine was running light and without cutting out it is found that the initial pressure is 60lb. per square inch, the pressure when the piston is at half stroke is 20lb., and the terminal pressure is 3lb. The word explosion seems here somewhat misapplied when one considers the extremely low steady pressure all through the stroke.

Graduation of Explosions.—The difficulty to be overcome was the prompt ignition of the charge without initial shock, and under the difficult conditions of a rich charge varying down to an extremely poor one, and also to reduce the terminal pressure by more complete combustion in the cylinder. Diagrams show the graduated nature of the explosions under varying loads after the final adjustment of the engines. It was noted that the charge ignites promptly and without shock, and that the low terminal pressure shows that the charge is also utilised to the best advantage. The quantity of air supplied to the cylinder is practically constant, the quantity of gas only is varied; and hence the difficulty of ignition. It is well known that a poor mixture of gas and air ignites slowly. The method adopted appears to indicate that stratification actually takes place in the gas-engine cylinder, and that for certain purposes it may be rendered of great use. The regularity of the ignition was attained by admitting gas to the cylinder later and later in the charging stroke; and even at full power a considerable quantity of air is drawn into the cylinder before gas is admitted. At light loads this results in the cylinder being almost full of air immediately following the piston, with only a small portion of rich and explosive mixture near the ignition chest. The ignition is controlled by a timing valve, which opens always at the same point of the stroke. The gas charge is varied by a novel device, which is controlled by the governor. The gas-valve is worked by an expanding cam, which may be described as an ordinary gas cam divided into three leaves in planes at right angles to the axis of the cam shaft. These three leaves are capable of being spread or closed by a sliding key, which slides in a keyway cut in the cam shaft, and is controlled by the governor. A helix upon the key engages the leading leaf of the cam, and when the key is moved longitudinally along the shaft in either direction by the governor, the cam is spread or closed as the case may be. The third leaf is fixed on the shaft, the middle leaf being loose on the shaft and having a slot in which works a pin fixed on the leading leaf. The key and cam are held in position by a detent, during the opening of the gas-valve, but immediately it is fully opened the detent is released, leaving the cam again under the control of the governor. A Buss governor is employed, and the gas-valves are gridiron slide-valves; all other valves are of the mushroom type.

Ignition.—The method of ignition is by hot tubes which are of ordinary wrought iron, nickel steel, and porcelain. The economical life of the wrought-iron tubes is found to be rather short; after about 15 hours the tube gets partially choked up, and gives late firing.

Lubrication and Packing.—The cylinders are provided with valve lubricators opening inwards; the oil is drawn in during the charging stroke. Asbestos packing is used for the piston-rod glands, and no trouble has occurred with hot rods, notwithstanding the high temperatures to which they are exposed; they are as bright and clean as those of a well-kept steam-engine. The lubricant is ordinary gas-engine oil.

Cooling Water.—The cooling water from the overhead tank is circulated by means of small centrifugal pumps driven by belt from the crankshaft of each engine. The evaporation is made up through a ball-cock valve connected with the tank, and supplied by the town water supply. The town water can also be mixed in any required proportion with the tank water. Separate connections are made to the cylinder covers and jackets; and regulating cocks are supplied for the necessary adjustments. When returned to the tank the water is discharged into a long timber shoot provided with a number of holes, by which it is broken up into a shower, thus presenting a larger surface to the atmosphere, whereby the cooling is accelerated. This plan has been found of distinct advantage; and on few occasions has water been required from the town supply, even when running four or five engines together. The capacity of the tank is 10,700 gallons at 4ft. depth.

Gas Supply.—The gas is supplied through an 8in. branch from the Corporation gas-mains, brought into the station at the Chapel-lane end and connected to three 500-light dry meters; the three are connected in parallel, and each is provided with a by-pass. The gas is conveyed from the meters through an 8in. main, which runs the whole length of the engine-room, supported by brackets on the columns. Each engine gets its supply from the main through a 3in. branch pipe, provided with a valve and gas-bag. The ignition gas is supplied through a separate pipe and meters. The horizontal engines each deliver their exhaust gases through 6in. branch pipes into a common 18in. exhaust main. A silencer is connected between the main and the uptake.

High-Speed Engines.—The high-speed vertical engines, manufactured by the Acme Gas-Engine Company, Glasgow, have four single-acting cylinders arranged in two lines of two in tandem, working on to opposite cranks. The pistons in the bottom cylinders form guides in the usual manner. The piston-rod, connecting the top and bottom pistons, passes through a water-jacketed cylinder, the packing being ordinary Ramsbottom rings on the rod. The gas-valves and mixture-valves are of the mushroom type, actuated by means of cams. The piston-valves, which control the exhaust and time the ignition, are worked from a small crankshaft fixed on the same level, and are parallel to the main crankshaft, being geared from it in the ratio 1 to 2 through steel spur and pinion. The camshaft is also worked from this, through an upright shaft gearing with both. These engines being of the closed-in type, the base forms an oil-chamber in which the crankshaft works. The bottom pistons and the bottom piston-valves are lubricated by the splash from the cranks. Lubricators are provided for the top cylinders only. The engine base is extended to take the dynamo, and the crankshaft is coupled direct to the armature shaft. A flywheel of 3ft. diameter is fixed on each end of the crankshaft, the one at the dynamo end weighing 28½cwt. and the other 24½cwt. Each cylinder is fitted with a stop-valve, so that the engine can be run on one or more cylinders as desired. Each cylinder is provided with an ordinary pendulum type of governor, and the usual method of governing by missing an explosion is employed. Ignition is obtained by means of the hot tube. When the engine is running at full load, at its normal speed of 380 revolutions per minute and no explosions missed, 190 impulses per minute are obtained in each cylinder, or a total of 760 per minute in the engine. This, aided by the heavy flywheels, gives a very steady running. The engines are provided with a separate silencer and exhaust-pipe for each line of cylinders. The cooling arrangements are practically the same as with the horizontal engine. Tank water is circulated by means of a centrifugal pump, and there is also a direct connection from the town water-mains. Cooling pipes are also fitted to the crank-chamber. This kind of engine is specially suited for steady driving, high speed being attained without knocking, all parts being in constant thrust. This is obtained by having a high compression (about 90lb. per square inch) in one or other of the cylinders at every up stroke. When the bottom right cylinder is exhausting, the top right is compressing, and *vice versâ*. The same operation occurs in the left line of cylinders, and by cushioning at the top of the piston-valve cylinder, the piston valves are also kept in constant thrust. Where economy of floor space is a consideration, this kind of engine is very suitable. An engine of 150 i.h.p. requires a floor area of 6½ft. by 5ft., or 32½ square feet over flywheels, and the combined plant, engine and dynamo of 72 kilowatts, necessitate only an area of 62½ square feet.

Starting Arrangements.—The engines can be started either electrically or by compressed air. In the electrical starting the dynamo is run as a motor off the omnibus bars, pulling the engine round until it begins to explode. First the machine is plugged on to the omnibus bar, the machine automatic switch being left open. A starting resistance is then plugged into the machine circuit, the resistance switch being on the off contact. The field of the machine is next excited from the omnibus bar, by closing the shunt switch on the top or bar contact. An initial start is given to the engine by the driver, and the current is switched on gradually through the starting resistance. As soon as the dynamo is up to speed the starting current is cut off. The voltage is then regulated by the shunt resistance, and the dynamo switched on to the circuit by closing the automatic switch. The closing of the automatic switch actuates the shunt switch, changing it over from the top to the bottom contact, and the dynamo then runs as a shunt machine. The electrical starting is worked from the switchboard by the engineer in charge. In starting by compressed air the engine has first to be turned by hand by the driver into the correct starting position. The stop-valve admitting the compressed air is then opened, and is again closed as soon as a few explosions have taken place. The dynamo is then run up to speed and its voltage regulated, and it is put on to the circuit in the ordinary way.

Compressed-Air Starting Apparatus.—The air-compressor has two water-jacketed single-acting cylinders of 4½in. diameter and 8in. stroke. The pistons are driven by opposite cranks.

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TABLE I.—Test of No. 6 Tandem Engine and Dynamo. Taken April 24, 1896.

Number of test.	I.	II.	III.	IV.	V.	VI
Duration of test, minutes	30	30	30	30	30	15
Load-factor, per cent.	120·0	100·8	74·8	52 3	25·2	exciting.
Mean speed per minute, revolutions	166 5	167·5	168 0	166 0	168·0	167 0
Mean amperes	285·7	241·5	179·4	125·2	60·2	—
Mean volts	240·9	240·2	240 0	240·1	240 0	240·0
Mean kilowatts	68 8	58·1	43 1	30·1	14·5	—
Mean electrical horse-power	92·35	77·9	57 8	40·3	19·4	—
Mean indicated horse-power	120·5	101·4	80 2	64 4	45 0	—
Kilowatt-hours	34·4	29·0	21·7	15·01	7·25	—
Electrical horse-power hours	46·1	39·0	28·9	20·2	9·7	—
Indicated horse-power hours	60·25	50 70	40·10	32·20	22·50	—
E.H.P. ÷ I.H.P., per cent.	76·6	76·8	71·8	62 7	43 2	—
Gas used, excluding ignition, cubic feet	1.247	1,115	1,010	953	874	394
Ditto, including ignition, cubic feet	1,260·5	1,129·3	1,024·2	968 1	888·3	401·4
Ditto, pressure, inch	1	1	$\frac{7}{8}$	1	1	1
Ditto, total cubic feet, per hour	2,521	2 258·6	2,048·4	1,936 2	1,776·6	1,605 6
Ditto, excluding ignition, per kilowatt-hour	36 3	38·5	46·5	63·7	120·5	—
Ditto, excluding ignition, per E.H.P. hour	27·1	28 6	35·0	47·5	90·1	—
Ditto, excluding ignition, per I.H.P. hour	20·7	22 0	25·2	29·6	38·8	—
Ditto, including ignition per kilowatt-hour	36·6	39·0	47 6	64·3	122·6	—
Ditto, including ignition, per E.H.P. hour	27·4	29·0	35·5	48·0	91·7	—
Ditto, including ignition, per I.H.P. hour	20 9	22 3	25 6	30·1	39 2	—
Water used, tank temperature, F.	85·5°	84·5°	84°	86°	83 5°	—
Temperature of jacket-water leaving jacket, F.	119°	108·4°	131·7°	106°	112°	95 5°
Water used, lbs.	10.915	6,550	11,280	6,360	6,375	5,650
Ditto, lbs. per kilowatt-hour	317·5	226 0	520 0	423·0	880·0	—
Ditto, lbs. per E.H.P. hour	237	168	391	314	657	—
Ditto, lbs. per I.H.P. hour	181	129	282	197	283	—

TABLE II.—Tests of No. 2 Single-Cylinder Double-Acting Engine Taken June 5 and 6, 1896.

Number of test.	I	II.	III	IV.	V.	VI.	VII.
Duration of test, minutes	30	30	30	30	30	30	15
Load-factor, per cent.	117·8	99·3	75·8	53·6	23·85	50·6	23·85
Mean speed per minute, revolutions	160·3	162 0	160 5	163·0	160·0	161·0	163 0
Mean amperes	214·8	183·0	138·8	96·3	44·3	55·0	43·8
Mean volts	144·7	143·0	143·7	147 0	141·8	242·4	144 4
Mean kilowatts	31·1	26·2	20·0	14·15	6·3	13·35	6·3
Mean electrical horse-power	41·7	35·1	26·8	19·0	8 45	17 9	8 45
Mean indicated horse-power	57·6	48·8	43·06	33·2	23·8	29·8	22 3
Kilowatt-hours	15·5	13·1	10·0	7·07	3·15	6·67	1·5
Electrical horse-power hours	20·8	17·5	13·4	9·5	4 22	8 9	2·11
Indicated horse-power hours	28·8	24·4	21·53	16·6	11·9	14·9	5 9
E.H.P. ÷ I.H.P., per cent.	72·2	71·8	62·3	57·3	35·5	60·1	37 9
Gas used, excluding ignition, cubic feet	604 0	540·0	495·0	485·0	448 0	317·0	133·0
Ditto, including ignition, cubic feet	610 6	546·5	501·2	491·7	454·3	323·9	136 9
Ditto, total per hour, cubic feet	1,221·2	1,093·0	1,002·4	983·4	908·6	647·8	547 6
Ditto, excluding ignition, per kilowatt-hour	38 9	41·2	49·5	68 5	142·0	47·5	84 5
Ditto, excluding ignition, per E.H.P. hour	29 0	30·4	36·9	51 0	106·0	35·4	63·0
Ditto, excluding ignition, per I.H.P. hour	21·0	22 1	23·0	29·2	37·6	21 27	23 9
Ditto, including ignition, per kilowatt-hour	39·4	41·8	50·1	69·4	144 0	48·5	87·0
Ditto, including ignition, per E.H.P. hour	29 4	31·2	37·4	51·7	107·0	36·2	64·8
Ditto, including ignition, per I.H.P. hour	21·2	22·4	23·3	29 6	38·2	21 72	24·5
Water used during test, lbs.	—	—	1,805	1,940	—	1,940	—
Ditto, per hour, lbs.	—	—	3,610	3,880	—	3,880	—
Ditto, per kilowatt-hour, lbs.	—	—	180	274	—	290	—
Ditto, per E.H.P. hour, lbs.	—	—	134	204	—	217	—
Ditto, per I.H.P. hour, lbs.	—	—	84	117	—	130	—

Note.—In Tests I. to V. both ends of the cylinders were working, no explosions being missed. In Tests VI. and VII. one end only of the cylinder was working.

The admission and delivery of air are regulated by slide-valves moved mechanically. The crankshaft carries on one end a flywheel and on the other a mortice-wheel, which gears with a steel pinion on the motor shaft. The power is supplied by a 6-h.p. electric motor, running at 800 revolutions per minute, and taking its current from the mains at 220 volts pressure. The air-receiver is 12ft. long by 4ft. diameter, made for a working pressure of 100lb. per square inch, and tested up to 200lb.; it is provided with safety-valve, pressure gauge, etc. A 4in. air-main from the receiver runs the whole length of the engine-room, with a 2in. branch pipe to each engine. In the tandem engines the connection is made to the back end of the back cylinder. The compressed air is admitted during the impulse stroke of that end by a valve actuated by a cam, thus giving an impulse every second revolution. The gas is cut off from the back cylinder while starting. As soon as an explosion occurs in the front cylinder the compressed air is shut off, the starting cam put out of action, and the gas turned on, letting the back cylinder take up its part of the work. In the single-cylinder double-acting engines the arrangement is the same, with only the difference in working that the gas is admitted to the front end of the cylinder while starting, but not to the back end. In the high-speed four-cylinder engines the compressed-air connection is made to the bottom right-hand cylinder, which for starting purposes is specially provided, firstly, with a valve to close the mixture-admission port, secondly, with an exhaust passage and a valve to close it, and thirdly, with an inlet for the compressed air. The valve of this inlet is worked by a double-throw cam, thus giving an impulse for every revolution in this cylinder. The speed increases quickly; and as soon as the explosions take place in the other cylinders, the compressed air is shut off, the starting cam thrown out of action, and the gas turned on to this cylinder.

Mains, Feeders, and Distributors.—These are mostly bare copper strip in concrete culverts. The strip is simply supported on earthenware insulators placed 6ft. apart, which are held in place by a pitch setting. The strip is laid in before the cover flags are put down; and extra copper can be drawn in at any time without raising the flags. Everywhere the culvert is placed beneath the footway. The lengths average 25 yards, and are built with a fall towards the junction-boxes, in order to all ow any water that may get in to drain off. The average depth of the copper below the surface is 20in. The space required for a three-way culvert for a distributing main is 27in. wide, with a minimum depth of 18in. below the surface. For a five-way culvert, which takes the distributing mains and a pair of feeders, the space required is 34in. wide with a depth of 18in.

Culverts.—These are built of cement concrete in the pro-

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portion of 5 of gravel and broken stones to 1 of Portland cement. The side walls are 6in. thick and the bottom 4in., all faced inside with cement. The covering slabs are 2in. Kilrush and Caithness flags. The culvert when dry is itself a fair insulator, which is a great advantage where there is a possibility of sometimes getting a sag of the strip between the insulators, as may occur through the carelessness of workmen. At street crossings and under narrow footways where there is no room for a culvert, insulated cables in cast-iron pipes are used. Connections between the lengths of strip, or between cable and strip, are made in the street boxes by means of gunmetal grip boxes, which clamp the ends together. The copper strip is 1in. wide and 0·2in. thick, giving 0·2 square inch section. This is the section used in all the distributing mains, both for middle and outer wires. When the lamp density—that is, the number of lamps per yard—increases, the section of the outer wires can be increased by putting in another strip on the top of the present. The section of the feeders varies from 0·4 to 0·8 square inch, according to the length ; the longest feeder at present is 520 yards.

The distributing mains are all in parallel, and are connected at as many points as possible in order to equalise the pressure. They are brought back to the station to supply current for the lighting, etc. The middle wire is brought back from four different points of the network. The pilot wires are in the form of three separately insulated conductors, twisted together and cased in lead ; some have paper insulation and others impregnated jute. The joints are protected either by a lead sleeve soldered to the lead covering and filled with insulating oil, or by being placed in a special joint-box which is filled with insulating material run in hot. The pilot wires are drawn into cast-iron pipes laid along one side of the culvert. On account of the wet nature of the ground and the comparatively low level of the city, special precautions had to be taken against water getting into the culverts or accumulating in them, and the aim has been to make the whole watertight. The street boxes are built of brick, faced inside with cement, and the bottoms are concreted. They are provided with a cast-iron frame and cover, the latter being filled with concrete. A watertight joint is made between cover and frame by the use of House's slow-setting cement. Junction-boxes placed in the roadway are provided with specially heavy frames and covers, the latter being filled in with wood blocks. The covers are provided with inspection plugs, which allow of a rapid examination of the system being made without lifting the covers. Any accumulation of water can be removed through the inspection plughole by means of a small hand-pump. A record is kept of the condition of the boxes, and of the dates of their having been pumped out. The covers are also lifted periodically for the ventilation of the culverts. No trouble has been experienced from gas accumulating in the culverts. At the laying of the mains all defective gas services were renewed ; and those that ran close to the culvert were coated with a mixture of pitch and tar. The service mains are rubber-covered cables drawn into wrought-iron pipes, which are laid from the nearest street box. They are connected to the Corporation main fuses immediately inside the building. The connections to the distributing mains are clamped in the case of bare copper strip ; and insulated T-joints are employed for connecting to cable. Throughout the system the positive and negative mains have certain relative positions under the footway—namely, the negative main or feeder is everywhere next the kerb, and the positive next the houses.

General Remarks.—From the experience here gained the author is of opinion that a gas-engine station necessitates more attention than a steam-driven station, and more drivers of a better class are required for a given power than in the latter station. A couple of men are always required for the electrical starting of an engine. Without their help the strain on the armature would be too great if the current were switched on when the machine was standing. The following statement shows the cost of current sold from January 23 to December 31, 1895 :

Number of units sold	82,771
Number of lamps connected (equivalent in 8 c.p.)	10,500
Revenue from sale of current	£2,186
Average price obtained per unit	6·34d.

	Cost of production. £	s.	d.		Per unit sold. d.
Fuel (gas)	501	3	0	...	1·450
Oil, waste, water, and stores, including ignition tubes	80	4	3	...	0·233
Salaries and wages at generating station	444	17	4	...	1·290
Repairs and maintenance of buildings, engines, dynamos, and accumulators	93	16	8	..	0 272
Repairs and maintenance of mains	76	4	6	...	0·221
Rents, rates, and taxes	236	0	0	...	0·684
Management expenses, etc.	413	9	11	..	1·200
Insurance	23	2	0	...	0 07
Total	£1,868	17	8	...	5·42

A machine can be started up and got on circuit in about two minutes, the stand-by units being kept plugged-up on the switchboard and the ignition tubes kept hot. For the sake of efficiency the machines are run as near to full load as possible, but as far as governing is concerned, they can be run at any part of their load. The cost of fuel (gas) per Board of Trade unit sold for the year ending December 31, 1895, worked out at 1·45d. This, with gas at 2s. 3d. per 1,000 cubic feet, is equivalent to 53·6 cubic feet per unit sold, or 59ft. per unit generated. The total efficiency of units sold to generated is 91 per cent. This is equal to an average consumption during the year of 44 cubic feet of gas per electrical horse-power hour. A curve for the cost of gas per unit of electricity generated and sold throughout the year shows that it varies very little, whatever the output may be. The cost of engine-room stores, including oil, waste, water, and ignition tubes, amounts to 0·23d. per unit sold, which compares favourably with steam-driven stations. Ignition tubes form a heavy item of the cost. Good results are now being obtained with porcelain tubes, which require only a short time to heat up. The cost of cooling water works out at a low figure, and this is due to the use of a tank of large capacity, which has special cooling arrangements.

The cables and copper strip were laid and jointed by the Corporation workmen. Messrs. M'Laughlin and Harvey, of Belfast, contracted for the buildings, and Messrs. Scott and Sillar, of Aberdeen, and Messrs. William Coates and Son, Belfast, for the roadwork. The cast-iron work was manufactured by Messrs. Maclaren and Messrs. Shaw and Co., of Glasgow, and the cables were supplied by Henley's Telegraph Works Company, Silvertown, and by the Callender Bitumen Telegraph and Waterproof Company, London. The copper strip was supplied by Messrs. Curtis, of Dublin, and by the British Insulated Wire Company. Messrs. Dick, Kerr, and Co., of Kilmarnock, and the Acme Gas-Engine Company, of Glasgow, supplied the engines and dynamos. The compressed-air plant was made by Messrs. Kerr, Stuart, and Co., of Stoke-upon-Trent. The Electrical Power and Storage Company furnished the battery, and Messrs. Holmes and Co., of Newcastle, the switchboard. The station started to supply current on January 23, 1895, with 2,300 8-c.p. lamps ; there are now 13,500 lamps of 8 c.p. connected with the mains. The following statement shows the quantity of units of electricity generated, sold, etc., from January 23, 1895, to December 31, 1895 :

	Units.	Units.
Quantity sold : public lamps—		
Private consumers by meter, at 4d. per unit	574	
Private consumers by meter, at 7d. per unit	82,197	
		82,771
Quantity used on works	3,822	
„ lost in battery	6,304	
		10,126
Total quantity accounted for		92,897
Quantity not accounted for		2,229
Total units generated		95,126

From this it will be seen that :

	Per cent.
Total efficiency	=91·0
Loss in batteries	= 6 7
Loss in main	= 2·3
	100 0

The total maximum supply demanded was 159,000 watts, which is equivalent to 5,300 30-watt lamps.

THE DOT WALL SOCKET.

The manufacturer of this speciality, Mr. A. P. Lundberg, has recently sent us a sample for inspection. The wall socket and plug illustrated below consist of incombustible material

throughout. The socket is remarkable for its neat and compact design, coupled with good insulation. The over all diameter of the base is only 1 13-16in., while the straight over all, with the plug in position, is 1⅝in. A fuse is provided in the base. The complete fitting is another instance of the pitch to which the manufacture of porcelain has reached. We need only add that the address of the maker is Bradbury-street, Kingsland, N., and that the prices are somewhat in proportion to the dimensions.

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MANUFACTURING SYNDICATES.

The recent combination of the two largest manufacturing firms in America came as a surprise to all. The firms in question had for years been fighting each other, and the war in prices and between types of machinery had done much to benefit the general public. Now we are assured that the removal of the competition will also be beneficial. This assurance is not in keeping with the history of such combinations in the past. The influence on the few rival firms left to oppose the huge combination now formed is also not likely to be invigorating at first, but we do not doubt that eventually the advantage will rest with the smaller firms. We do not mean by the term small firm that the firm in question is one undermanned and ill-equipped, but rather a firm owned or controlled by one man. Such a firm small enough to be under the thorough control of one capable engineer will always be able to hold its own in manufacture. In the first place, it is untrammelled, and can move more quickly with the times. Then, the dead-weight of over-capitalisation which has to be borne by practically all these large combinations of interests is absent, and the financial problems are correspondingly simple to deal with. The great gain is, however, due to the personality of the control. This pervades all departments, and ensures better work from all concerned. As a gentleman said when referring to the Russian Government, "With an autocratic government, if you can state your case to the autocrat, you either get justice, and get it quickly, or else you never get it, and go elsewhere." So with a firm under autocratic control, the individuals forming the staff are all under personal supervision, and good men get a chance of adequate promotion. The promotion is, in fact, in some degree proportionate to the capabilities of the man in question, and not, as is the case with large syndicates, on his backstair influence. The man with inventive ideas takes his original methods of cheapening the cost of manufacture to the head of the firm, and stands a fair chance of getting some return. With a large combination of interests the financial head invariably gains supreme control, and as a consequence the engineering staff suffers. We even know of a case where the financial element has such a predominating influence that it has fixed a maximum salary, and that a low one, beyond which no member of the staff other than the head of a department shall rise. Such regulation and method of control tend to stagnation, and the members of the staff lose all incentive to excel. It is not, however, only in this way that unduly large concerns suffer. They are almost always under the control of some financial clique, and consequently are run in the interest of this clique. The way in which this interest tends is seldom apparent at first, but it is nearly always disastrous in the long run. It is the old story—either the clique keeps control and bleeds the public and shareholders, or else the shareholders demand redress and get reconstruction after writing off a large proportion of their capital. The abstract question is perhaps not so interesting as the query

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as to what action the new American syndicate will take over patent rights. They will undoubtedly own the major portion of the patents of recent years dealing with electrical matters. Such of them as are valid they have a perfect right to rigidly enforce. What we object to is the interference with other manufacturers on invalid grounds. Perhaps the different patent law in America may alter the case, but in England it has too often been a case of length of pocket rather than validity of claims. Thus we hear rumours that sole rights for compound winding, the lamination of armature cores, and the use of carbon brushes are going to be claimed. We only trust such rumours are inaccurate, and that the English patents owned by the combination will not be the cause of heavy lawsuits.

THE TELEPHONE IN RAILROAD PRACTICE.*

BY W. W. RYDER, OF CHICAGO.

The growing use of the telephone in railroad work and its present advantages and present possibilities is a subject well worthy of consideration and study. The telephone equipment at local points best adapted to the transmission of the internal business of a railroad depends upon the location and degree of concentration of the offices at each point. The value of a private telephone line connecting intermediate points and the division headquarters along the line of the road is dependent to a large extent upon the number of instruments that are enabled to secure intercommunication thereby. In connection with the speaking-tube or internal telephone system special efforts are being made by the local telephone companies to offer the railroad companies instruments and apparatus that vary with the character of the service desired. For instance—

System A: A central switch with lines radiating from it, each line having one or more stations connected with it, the whole being arranged for intercommunication.—This system is operated in much the same manner as an ordinary telephone exchange, a switch being located at some central point provided with means for calling and receiving calls from each station, and for connecting the several stations with each other. The switch may be located where it can be operated by some person in connection with other work, or if the system is large the services of a regular operator may be required. This system (if but one station is connected on each radiating line) secures secrecy between any two stations, and provides for independent communication between a number of stations at the same time.

System B: A switch at a particular office with lines radiating from it, each line having one or more stations connected with it, the whole being arranged for communication to and from this particular office, but not for communication between stations on different lines.—This system is used for transacting business between a particular office and several stations in cases where it is not required that the stations communicate with each other. A switch is provided at the main office only. This system (if but one station is connected on each radiating line) secures secrecy between the main office and any one of the stations.

System C: A switch at each station, with means for connecting the instrument at such station with lines extending to each of the other stations.—This system is so arranged that a person at any station can call any other station over a special line and establish the desired connection without the aid of an operator. It does not secure secrecy to such a degree as systems "A" or "B." A switch being located at each station access may be had to all circuits whether in use or not, but as the bell at the desired station is the only one operated when a call is made secrecy is fairly assured, and interruptions are not likely to occur unless the use of the same circuit should be desired by a second party, and his instrument be connected for the purpose of making a call. It is possible for parties at several stations to converse independently with each other at the same time.

System D: A single circuit connecting two or more stations.—All instruments being connected upon one circuit no switching apparatus is required. Only two stations can use the line at one time, and there can be no secrecy, as a call made from any station will ring all bells simultaneously.

Systems "A" and "B" are especially adapted and serviceable for freight offices and yards, round houses, switching towers, etc. System "C" is perhaps the most convenient and satisfactory when the stations to be connected are not numerous. System "D" is the most simple and inexpensive.

An outgrowth from system "A" is the present private branch telephone exchange. The benefits derived from the establishment and operation of private branch exchanges seem comparatively unknown, and especially so to those who have not been closely in touch with the growth of this particular line of the business, and it is with a view of arousing interest in this direction, as well as securing additional information through the discussion which I trust will follow this paper, that I have endeavoured to collect as much reliable information as possible bearing upon this subject. This very lack of familiarity with the branch exchange frequently results in a much less efficient service from a given number of telephone lines than would be secured were they merged into the so-called exchange.

"In the march of civilisation the improvements of yesterday are discarded for those of to-day. The tin speaking-tube once used for interior communication gives way to the telephone. In this age, when only time saving is considered more important than labour saving, and the combination of both is the prime object with all active minds, the importance of rapid and reliable communication can not be over-estimated. Especially true is this of the business conducted in a large building where the labour and delay incidental to employing messengers or office boys make an important item of expense. In the general offices of a large railroad company, where every office can be connected one with another, and the various working departments be brought into talking relations with one another, this telephone service is a time, labour, and money saver; and where the heads of departments are separated from each other by doors, stairs, and passages it is invaluable."

Every railroad man is familiar with the general scheme of railroad organisation, and the relationship between the various departments, their chiefs, etc. The lines of authority are closely drawn, and the flow of communication naturally follows these divisional lines. As the division of responsibility among the several officials and employés who carry on the operation of the railway company is plainly defined, so the uses of the telephone tends to parallel those divisions of responsibility and to follow the lines which separate the duties which are to be performed. In the application of the telephone to the transaction of internal business at local points, and within a certain radius of the office building or about the yards and switching centres, the numerous communications necessary are passed to and fro easily and without loss of time. The tendency is toward the constant growth of private branch exchanges, as they give more perfect interchange of communication for every class of business, concentrate the service within certain limits, and enable the business to be transmitted direct without going through the medium of the local telephone operator, and vary the class and extent of the service desired according to the price paid.

The benefits to be derived from the operation of the private branch exchange has been recognised to a greater extent in the city of Chicago than elsewhere in the country. As a matter of fact, there are at present in that city over 130 private branch exchanges, operating an aggregate of over 1,200 telephone instruments. These exchanges are operated by railroad and express companies, large wholesale and retail establishments, manufacturers, etc., and range in extent from four to 100 instruments. They are connected by means of trunk lines with the local telephone company's exchange, so that connections may be had with the public. In a great many cases a particular telephone, while greatly needed for the handling of railroad business, has no occasion for public connection. If arranged so that

* Paper read before the Association of Railway Telegraph Superintendents, Fortress Monroe, Va., June 17.

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they can secure such connection, the result is that the telephone will be used more or less for private ends, consequently when the public trunk lines are required for legitimate railroad business, they will be reported "busy," while, as a matter of fact, they are being used for private business.

To obviate this evil and to furnish as nearly as possible what is absolutely required, the local telephone company has recently adopted a scheme whereby it is made impossible to give certain offices public connection, although they are able to secure unrestricted intercommunication with every line radiating from the branch exchange. In giving this limited service, the telephone company charges a considerably lessened rental, although securing for the subscriber a more efficient service by not allowing the unnecessary blocking of his down-town trunk wires. This difference in expense, together with the difference in price between public and branch exchange lines, is almost, if not quite, sufficient to pay the salary of the telephone operator even though you have only a small number of lines, and this naturally increases with the greater extent of the system. The success of the system can best be indicated by the statement that of all the branch exchanges put in operation in the city of Chicago, only one has ever been taken out through dissatisfaction with the system, and in this case it was only a short time before the telephone company was requested to immediately replace it, the firm finding that the inconvenience and loss of time were greatly increased when the exchange was closed.

The growth of the private branch exchange system must soon extend along the lines of the individual railroads; in fact, at present the Pennsylvania Railroad Company has in operation a very complete system which gives them direct connection over wires entirely controlled by them between all division headquarters on their road east of Pittsburgh. Through the courtesy of that company I am permitted to exhibit a diagram of this system. They have branch exchanges at all division headquarters, and have leased from the Long-Distance Company necessary wires to complete connections with these points. Other large eastern lines, I understand, are now contemplating the adoption of this same scheme. With the growth of the private branch exchange idea, these exchanges will rapidly multiply in large cities, and the necessity for means of intercommunication between them without going through the public exchange will become imperative; in fact, in the city of Chicago, at present, where branch exchanges are being operated by the Chicago and Northern Pacific, Chicago, Rock Island and Pacific, Chicago, Milwaukee and St. Paul, Chicago and Eastern Illinois, Illinois Central, Chicago and North-Western and Chicago, Burlington and Quincy Railroad Companies, this necessity is very noticeable, and the local telephone company is considering the question of trunking the different exchanges together. With this accomplished, it is but a step to the connection of the branch exchanges in one city with those in another over wires controlled by the railroad companies. How this can best be done can only be decided by trial, and I believe we will have to meet this particular issue at a very early date.

When we consider the rapid growth of the telephone system it seems a question of only a short time before the telegraph will be largely superseded by the telephone. It has been shown in actual practice in commercial service that messages of 30 words can be readily and intelligently transmitted in a quarter of a minute, or 120 words per minute, which is about 3,900 better per hour than the average by Morse, using the Phillips code and the typewriter. The above record is taken from a guaranteed service where the toll service is daily performed on this basis.

The question of the telephone not being able to compete with the telegraph on account of the lack of records was happily answered, you will recollect, by Superintendent Seldon in a paper read before this association at the 1894 meeting, and this feeling, I believe, is rapidly passing away. The despatching of trains by telephone has been tried with perfect success in several instances in this country. This is the most exacting of service, and the fact that it is a success speaks volumes for its efficiency. It is a well-known fact that large corporations are slow in adopting radical changes, but the improvements in telephone apparatus are so marked, and the benefits derived from its use so evident, that they are being forced to recognise its merit, and consequently are rapidly advancing the movement.

THE NAGLO EQUIPMENT FOR TELEPHONE EXCHANGES.—SYSTEM HESS-RAVEROT-WEST.

BY JULIUS WEST.

Amongst those considerations which determine the value of a telephone system, reliability and speed of working are the most important; these two features make it very desirable, even in local systems, to have all the subscribers of one town connected to one single exchange. In the case of interurban systems the need for dealing with all subscribers in one central exchange becomes even more pronounced, in order to minimise the time necessary for making the connections, and thus to utilise as efficiently as possible the expensive trunk lines. This necessity has for some time past induced numerous telephone engineers to look for some means whereby it should become possible, in view of the large increase of telephone systems, to build exchanges of any desired extent. It has been tried to increase the number of possible connections in multiple systems by reducing the size of the constituent spring contacts, in order to accommodate more of these plug switches in a switch-panel, the size of which must be in some proportion to the reach of the operator. It has thus become possible to increase the number of connections in exchanges on the multiple system to about 10,000. This expedient is, however, insufficient, since we have even at present a number of systems larger than this, and as the above-described arrangement embodies some danger to the efficiency of working, it can only be regarded as a partial remedy. The problem has been attacked more effectively by others, who endeavoured to introduce a new principle, by which the number of connections possible could be increased. I refer to the systems of Siemens and Halske, to that of Engelmann, to the "divided board system" (related to the foregoing) which was used at Albany, and to the "express system," introduced rather more than a year ago at San Francisco. These arrangements, which differed more or less from the original multiple system, permit of connecting up a much larger number of subscribers than the limit given above. They all necessitate that the lines must be switched on and interrupted at two points corresponding to the connection of two or more exchanges on the multiple system in a town. They therefore do not offer sufficient advantages to compensate for the saving in line material otherwise effected when establishing several exchanges, although under certain conditions they may, however, prove valuable.

A happy and rational solution of the problem was found by Messrs. G. A. Hess and P. E. Raverot, of Paris, who have invented a new connection for telephone exchanges based upon the principle of arithmetical combinations. In their system the switching operation need only take place at one point, so that we get the improvement desired in working by the combination of all subscribers' wires in a central exchange.

Fig. 1 shows the connections used in the Hess-Raverot combination system. From it, it appears that the subscribers are to be divided into groups which we may for the time denote by the letters of the alphabet. As will be shown later on, these groups may each comprise about 1,000 subscribers. Every group is represented by a number of switch-panels, with one plug switch for each subscriber. Two of these panel boards are combined to so-called subscribers' boards. If we have, for example, four groups, *a b c d*, and place these boards in a row, we get the following combination:

a b ac a d bc b d c d.

Since the wires for group *a* are connected in multiple through the switchboards *a*, those of group *b* through switchboards *b*, etc., the combination boards, as indicated by the above series, enable us to connect two subscribers direct. If, for instance, *a* No. 12 wishes to speak to *b* No. 209, the connection is effected on board *a b* by means

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of a double cord, and if *a* No. 12 desires to call *d* No. 35 the connection is to be made on board *a d*.

From the combination board the wires lead to the operator's board, where they are represented by a plug switch and an annunciator in such a way that the switches and annunciators of one group form a board, which is divided into several operator tables. When an annunciator drops, the operator can switch himself on to that particular subscriber. For example, *a* No. 12 receives his connecting order—say, *b* No. 209—and has then to transmit this order to that combination board which alone can effect the desired connection, which in this special case would be board *a b*; the transmission of the order "*b* 209 with *a* 12." is made by telephone, and the operator at board *a b* effects the desired connection as usual, and on termination of the conversation interrupts it again.

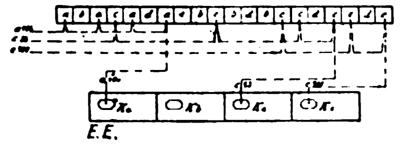

Fig. 1.

It is obvious that the number of these groups may be increased at will without altering the working conditions, and this system thus permits of erecting rationally and quick working exchanges with 50,000 subscribers, and even more.

This method of connection from the very start offered such striking advantages that I considered it advisable to assist in its introduction. I therefore, in connection with Messrs. Naglo and Co., elaborated on this basis a system which is shown on a small scale at the Berlin Industrial Exhibition of 1896, and I propose to describe this system as applied to this experimental exchange.

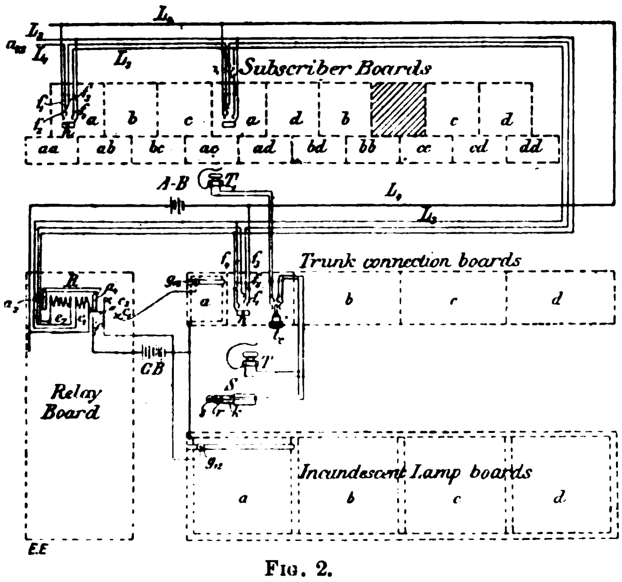

Fig. 2.

If we consider the above row of combination boards as a continuous row of adjoining switch-panels,

a b a c a d b c b d c d,

it is obvious that each letter stands twice at the side of each other letter—*i.e.*, we have *a b* and *b a*, also *a c* and *c a*—so that the connections may be effected in two places, which is superfluous. It becomes thus possible to cut out several letters from the series, and to reduce the above row to

a b c a d b c d,

in which every letter adjoins another but once. For an exchange with five groups we have

a b c a d b e c d e a.

As compared with the series for four groups, an *e* has been introduced between the second *b* and the second *c*. For future extensions provision has to be made from the start; so that the row of boards for four groups ought to be *abcadb-cd*, where the switch-panel—as indicated by the dash (-)—remains vacant, until it is fitted later on with the spring switches for group *e*. For an exchange with ten groups the combinations would be

abcadbecdeafbgcfdgefgahbichdiehfighiakb-ckd-ekf-gkh-ik

which already provides for an eleventh group *l*, so that future extensions may be easily carried out.

This arrangement of the switch-panels makes it necessary to carry all the subscribers' wires along the whole length of the panel rows, and in this respect a limit is very soon reached, when it becomes no longer practicable to carry out this arrangement of the wires, as the number of cables leading through the panels and their length would become unwieldy. When this limit is attained, it will be found of advantage for the proper distribution of the wires to use the arrangement given in the following formula. The original Hess-Raverot arrangement was

ab	*ac*	*ad*	*ae*	*af*	*ag*
	bc	*bd*	*be*	*bf*	*bg*
		cd	*ce*	*cf*	*cg*
			de	*df*	*dg*
				ef	*eg*
					fg

where the *a* cables lead through the upper panel row (vertical row), the *c* cables, however (as indicated by the lines), through the second panel of the first row, then the first panel of the second row, and, finally, through the third row; but, as mentioned before, this arrangement labours under the disadvantage that all the operator fields are twice represented, which may, however, be easily avoided if we combine in a horizontal row, not one, but two letters with the remaining after the formula:

a b c a d b e a f b g a,
c d e c f d g c,
e f g e.

(*To be continued.*)

ALTERNATE-CURRENT TRANSFORMERS.*

BY DR. J. A. FLEMING, F.R.S.

LECTURE II.

The Construction of the Transformer.

In the previous lecture we have examined the general facts connected with the action of the transformer, and we have next to consider questions of transformer construction. The three organs of a transformer being the primary and secondary circuits and the iron core, the constructive problem is reduced to winding these circuits on the core, and properly constructing that core to receive them. We will consider, in the first place, the manufacture of the core. This has to be built up of iron wire or sheet iron, so divided or laminated that eddy currents cannot be set up in it. If it were not for this lamination, the periodic change of induction taking place in the core would set up in the mass of the metal local electric currents which would dissipate energy. Mathematical investigation has shown that, for frequency of 100, or thereabouts, it is useless to make the iron—whether in the form of wire or sheet—less than 1-100th of an inch in thickness—that is, about one-quarter millimetre—and useless to laminate it all, unless the laminations are less than one millimetre in thickness. You will find in the *Electrician*, vol. 28, pp. 599 and 631, investigations by Prof. J. J. Thomson and Prof. Ewing, which deal elaborately with this matter. I have found that their rather complicated formulæ are not fitted for use in the workshop, but that they can for all practical purposes be replaced by a much more simple formula which furnishes all the necessary information for transformer core construction. In the case of good sheet iron, and for the range of induction usually employed in transformer work, which is not more than 3,000 or 4,000 C.G.S. units, that is to say, 30 to 40 microwebers per square centimetre, if we represent the eddy-current loss in watts per cubic centimetre of the plates by a symbol, E; and if we call *t* the thickness of the plate in mils—that is, in thousandths of an inch—and if B is the maximum value of the induction per square centimetre in C.G.S. units, and *n* the

* Cantor lectures delivered before the Society of Arts.

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frequency, then it can be shown that very approximately $E = \left(\frac{t\,n\,B}{10^8}\right)^2$. Although this is a hybrid formula, containing units of different kinds, and may be horrible to purists, it will nevertheless be useful in the drawing office, and we can simplify it still more if we reckon the maximum induction in webers, and call I this induction per square centimetre, then $E = (t\,I\,n)^2$. In some works it is the custom to reckon the induction per square inch, instead of per square centimetre, and the thickness of the plate in fractions of an inch. If $t_,$ is the thickness of the plate in inches, and $B_,$ the induction per square inch, and $E_,$ the eddy-current loss in watts per pound of plates, then $E_, = \frac{1 \cdot 4}{10^{10}}\,t_,^2\,n^2\,(B_,)^2$. The general custom is to use plates for transformer construction of about ·014in. in thickness, and the standard induction which is generally selected is 2,500 lines of induction per square centimetre, or 2,500 C.G.S. units. This is equivalent to 16,125 per square inch. Under these circumstances, by the above formula it is shown that the loss in watts per pound of plates due to eddy currents would be ·07 watt, the frequency being 100. It may be noted that any increase of temperature as the transformer is worked by increasing the resistance of the iron tends to diminish the eddy-current loss. It will, therefore, be seen that by employing plates of a thickness not greater than 14 mils, eddy-current loss is reduced to a very small amount. One point, however, to which your attention ought to be called is that unless the iron plates are properly arranged, eddy-current loss may exist in them, however thin they may be. If either by reason of magnetic leakage or any other disposition of the magnetic induction, lines of magnetic induction move through the iron in such a manner that their direction is not always parallel to the direction of the lamination of the iron, then under those circumstances eddy currents may be set up in the core which are not hindered by lamination. This source of waste was present in many of the earlier forms of transformer. In addition to the loss of energy caused by eddy currents in the core, there is, of course, that other source of loss called the hysteresis loss, which is due to the magnetisation and demagnetisation of the core, and to the fact that the induction is not in step during the whole period with the magnetising force, but lags behind it. The investigations of Steinmetz have shown that the hysteresis loss in iron sheets can be represented by a simple empirical formula which fits the facts fairly well. It is found that the hysteresis loss per cubic centimetre per cycle in the iron is related to the maximum value of the induction during the cycle by a simple exponential law, and may be, for all practical purposes, closely expressed by the following formulæ :

Let H = hysteresis loss in watts per cubic centimetre,
and H^1 = hysteresis loss in watts per pound ;

then
$$H = \eta\,n\,B^{1 \cdot 65}\,10^{-7}$$
$$= \cdot 0032\,n\,B^{1 \cdot 55}\,10^{-7},$$

where n in the above formula is the frequency, and η is a coefficient called the hysteretic constant, which depends upon the nature of the iron. The value of η may vary from ·002 to ·005. If we reckon the hysteresis in watts per pound, then we have

$$H_, = 0 \cdot 88\,n\,(B^1)^{1 \cdot 65}\,10^{-9},$$

where $B_,$ = induction per square inch.

The exponential constant may vary from 1·55 to 1·6. Thus, for example, if $n = 100$, and if $B_,$, the induction per square inch = 16,125, corresponding to induction per square centimetre of 2,500, then $H_, = \cdot 29$ watt per pound, and $H = \cdot 005$ watt per cubic centimetre. These formulæ have been deduced from experiments made with various kinds of transformer iron; and although they are empirical formulæ, in the sense that they are not deduced from first principles, yet, nevertheless, they are exceedingly useful, and agree so well with experience, that they enable us to calculate the hysteresis loss at any one induction when we know it at another. We may, therefore, put together the two expressions obtained for the eddy-current loss of the hysteresis loss in iron and state that, for all practical purposes and within the limits of the induction usually employed in transformers, the total energy loss in the iron, made up partly of eddy-current loss and partly of hysteresis loss, may be expressed as follows :

T = the loss per watt in cubic centimetres ;
$T_,$ = the loss in watts per pound ;

then
$$T = \cdot 0032\,n\,B^{1 \cdot 65}\,10^{-7} + \left(\frac{t\,n\,B}{10^8}\right)^2.$$

$$T_, = \cdot 088\,n\,(B_,)^{1 \cdot 65}\,10^{-9} + \frac{1 \cdot 4}{10 \cdot 10}\,(t_,\,n\,B_,)^2,$$

where B is the maximum induction in C.G.S. units per square centimetre, and $B_,$ per square inch.

The curves in Fig. 25 show the variation of hysteresis and eddy-current loss in plates of various thickness for a maximum value of the induction of 4,000 C.G.S. units calculated from the formulæ of Prof. J. J. Thomson.

My own experience is that these formulæ agree very well with experience and with the results of measurement. I made some years ago a careful study of the old-form Ferranti transformers, and found a very fairly close agreement between the results of measurement of the core loss in these transformers and the results obtained by calculation from the above formulæ. In specifying for iron for use in transformers, it is now the custom to adopt a standard induction of 2,500 C.G.S. units, or lines of induction per square centimetre ; that is to say, the standard induction is 25 microwebers per square centimetre — and the standard frequency is 100.

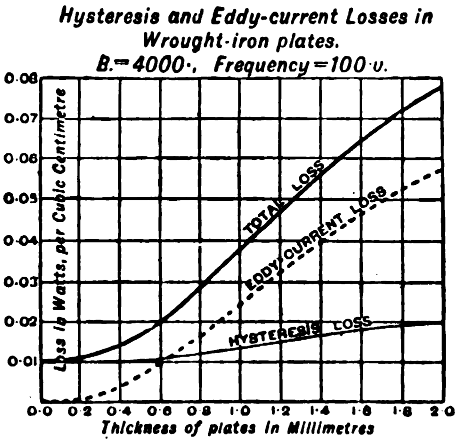
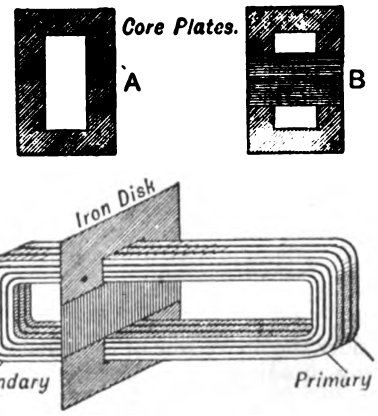


FIG. 25.

Under these conditions a good transformer iron ought to have a hysteresis loss varying from ·25 to ·5 watt per pound. It is possible under some conditions to get iron with less hysteresis loss than this, but, as we shall see presently, there are some difficulties in keeping it in this condition. Having selected the iron, the next thing is to stamp out the core plates and afterwards to carefully anneal them. It is now well understood that the slightest tooling or handling of iron after it has been annealed hardens it and raises its hysteresis loss—hence the greatest care has to be taken that the plates are not damaged after annealing. The plates have then to be insulated to keep them from electric contact with one another. The old practice was to insulate the plates with thin paper, but paper takes up too much space, and it is now usual to paint the plates with an insulating paint or varnish, which, however, must be able to



Mordey's Transformer.

FIG. 2 .

withstand, without deterioration, the highest temperature which the transformer may reach in work. Even using varnish, the varnish takes about 10 per cent. of the space of the iron. In selecting the iron for the core plates, it is more important to choose an iron with small hysteresis loss than large permeability. These two things are not necessarily connected together. The number of devices which have been adopted for cutting the iron into the core plates, as to avoid unnecessary waste of metal, is very large. In Fig. 26 is shown the manner of building up the core of a Mordey transformer. In Fig. 27 the mode of building up a Westinghouse transformer is also shown. In this case, as in that of the Mordey transformer, where a cross-piece is used, or where there are

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overlapping iron plates, it is customary now to use packing pieces of sheet iron to fill in the levels, and to get as much iron as possible into the space. In Fig. 28 is shown the method of stamping the core plates from the sheet and constructing the Scott and Addenbrooke transformer. The iron core having been constructed in such a manner as to afford a completely closed iron circuit for the lines of induction due to the magnetising force of the primary coil, the core is then covered with shellaced calico and mica, in order to insulate it from the primary coil; and the greatest care ought to be taken in this respect, because it is not sufficient to insulate the coils

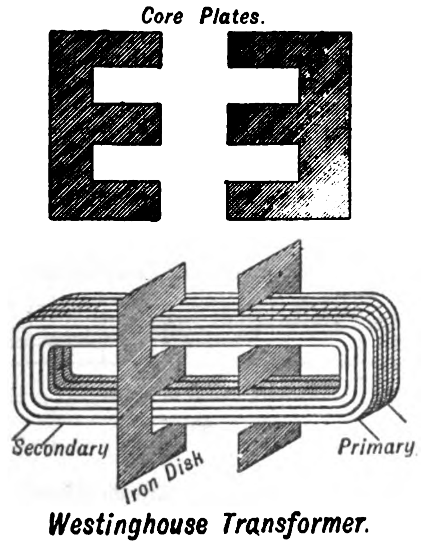

Fig. 27.

of the transformer from one another: they must both be insulated from the core. Thin ebonite is often used as a material for insulating the core, and an indiarubber compound called woodite is a very good material to use. The primary and secondary coils are generally wound on formers; they must be insulated from each other by ebonite or mica, and the primary and secondary coils should be so overlaid or intermingled (as shown in Fig. 29, which represents a typical closed iron circuit transformer) to avoid producing magnetic leakage. In large transformers it is customary to leave a space between the high and low tension coils for the purpose of ventilation, and in the same way air spaces or ventilation spaces have to be left in the iron core. The primary and secondary coils are sometimes separated from one another by a metal shielding plate, which is connected to earth. This is, however, not so good a plan as

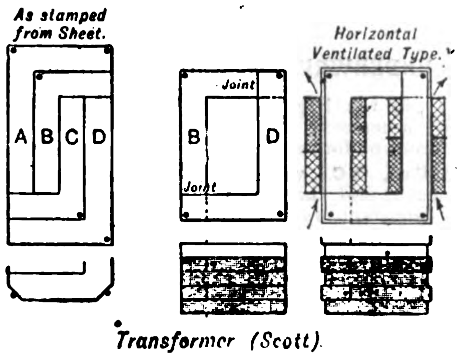

Fig. 28.

an effectual separation of the primary and secondary coils by an insulating shield. In the design of the core it is important to reduce the reluctance of the magnetic circuit as much as possible, in order to produce a large power factor. The term "power factor" is defined as the number representing the ratio between the true power taken up in the core to the product of the primary potential difference and the primary current (root-mean-square values being understood). This product is called the apparent power taken up in the core.

We shall consider in a later lecture the disadvantages of a small power factor. Meanwhile, it may be said that a small power factor in a transformer, when taken at no secondary load, is always an indication of large magnetic reluctance in the magnetic circuit, and hence open iron circuit transformers have always small power factors. The primary and secondary coils, having been placed upon the core and insulated from one another, the transformer is put into an iron case, which is constructed to be watertight. Many manufacturers include in the same case porcelain plates or terminals, to which they attach the extremities of the primary and secondary coils. This, however, is not so good a plan as connecting by a highly-insulated joint the extremities of the primary and secondary coils to highly-insulated cables, which are brought out through watertight glands in the iron case, any necessary connections to fuses or switches being then made outside. In the design of large transformers one important consideration is getting rid of the heat. A transformer ought never to rise above 100deg. C. under any conditions of use, and for every watt which is lost in hysteresis and by copper resistance at least three to four square inches of cooling surfaces must be provided. In the case of very large sub-station transformers, it has even been found advantageous not only to leave ventilating spaces in the core, but to force a draught of air through

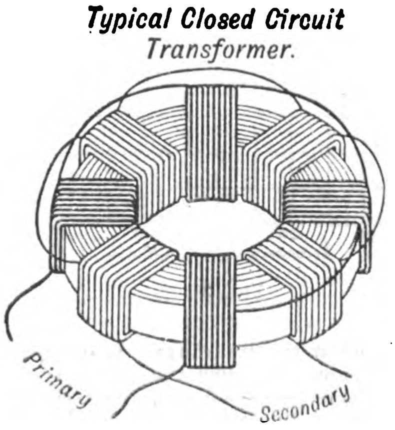

Fig. 29.

the transformer to keep it cool. In some cases a highly insulating oil is put into the case, but the insulation of the transformer must be good enough to work without it. The use of the oil is merely to keep out damp air, and even then it is not always successful in preventing breakdown. The notion that oil could be used as an insulation for transformers, which would heal up again after the passage of a spark or arc, was not confirmed by experience. As regards the general design of transformers, the battle of open *versus* closed iron circuit transformers was fought out and decided long ago. Open circuit transformers—such as the hedgehog transformer—have no

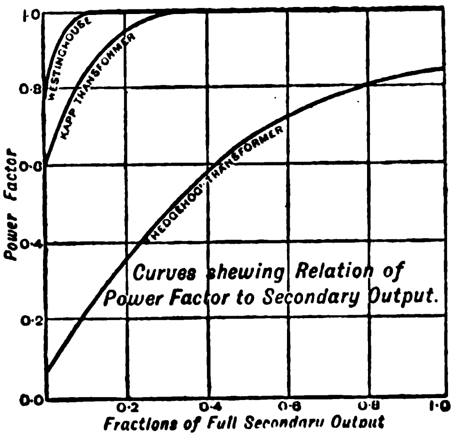

Fig. 30.

advantage over the closed iron circuit transformer in respect of core loss per kilowatt output, and they have a decided disadvantage in a smaller power factor. Moreover, in a closed iron circuit transformer, as the transformer is loaded up, the power factor very soon reaches unity; the curves in Fig. 30 show the manner in which the power factor of several different types of transformer varies as the transformer is loaded up. In a good closed iron circuit transformer, with small magnetic reluctance, a very little loading of the secondary circuit brings the power factor up to unity. In the case of a six-kilowatt Mordey transformer I found that, loading up to 1-60th of full load, brings the power factor up to unity. The advantage of large power factor means that we have a small root-mean-square value in the magnetising current at no load, and, therefore, a small heating loss in the main supplying the current of that transformer. When the transformer is at work we not only have energy losses going on in the iron, but at the same time we have energy losses in the

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copper, called the copper losses, which are due to the resistance of the copper circuit. It can be shown the most advantageous ratio between the copper losses and the iron losses is to so construct the transformer that at full load the total copper losses are equal to the total iron losses. In very large transformers, where the secondary circuit consists of very thick copper bands or wire, if magnetic leakage exists to any sensible extent, we may have eddy-current losses set up in the copper circuits, and this, in addition, may be a source of energy waste. The copper resistance operates not only to cause a large energy loss, but partly to account for what is called the secondary drop of the transformer. If a transformer is connected to a constant-potential primary circuit, and if the secondary circuit is gradually loaded up, the potential difference between the secondary terminals is less when the transformer is fully

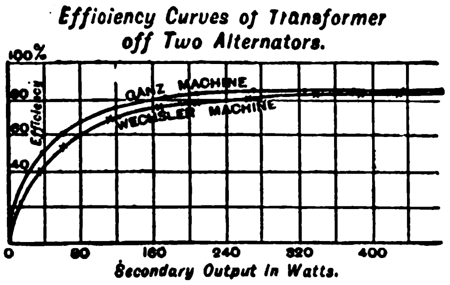

Fig. 31.

loaded than it is when the transformer is on open secondary circuit. This difference is called the secondary drop. This drop is due to three causes—firstly, the resistance of the primary circuit; secondly, the resistance of the secondary circuit; and, thirdly, to magnetic leakage. As far as regards the copper resistance, we may calculate the secondary drop by the following formula :

$$\text{Secondary drop} = \frac{100 \times (C_1 - \textit{mag. cur.})\, R_1}{E_1} + \frac{100\, C_2\, R_2}{E_2},$$

where C_1 is the R.M.S. of the primary current;
C_2 is the same value for the secondary current ;
R_1 is the resistance of the primary circuit ;
R_2 is the resistance of the secondary circuit ;
E_1 is the difference of potential between the primary terminals ;
E_2 is the difference of potential between the secondary terminals ;

taken when the transformer is on open secondary circuit, and the symbol *mag. cur.* stands for the magnetising current of the transformer—that is, the primary current when the transformer is on open secondary circuit.

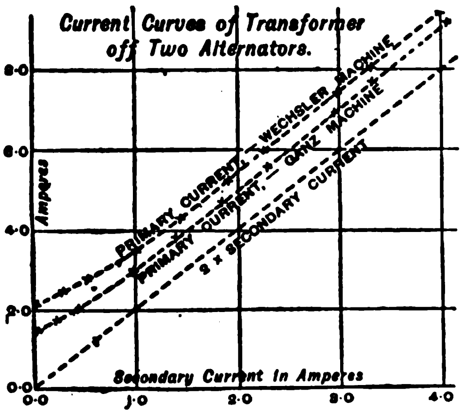

Fig. 32.

This formula, however, only gives us that part of the drop which is due to the copper resistances ; the actual observed drop would be greater than this by an amount due to magnetic leakage.

In dealing with the testing of transformers in our next lecture, we shall discuss the method by which this drop may be measured. In considering the action of transformers, it is important to notice that the iron core loss of the transformer, the secondary drop, and the power factor of the transformer at no load are all greatly affected by the form of the curve of primary E.M.F. It is the custom sometimes to speak of the core loss of a transformer as if it were a quantity inherent in the transformer itself, and which could be exactly specified for any particular instrument. As a matter of fact, this is not the case. Experiments carried out with different transformers worked on different alternators by Dr. Roessler in Germany and by myself in England, have abundantly demonstrated that the form of the curve of primary E.M.F. has an immense influence on all the above-mentioned quantities. Dr. Roessler employed two machines— one a Wechsler and the other a Ganz alternator. When these machines are running on open circuit, the Wechsler alternator gives a curve of E.M.F. which has a well-rounded form ; whereas the Ganz machine has a curve of E.M.F. which has a very sharp or peaked form. The machines I chiefly employed in my own experiments were the Mordey alternator, the Thomson-Houston alternator, and a Ferranti machine. The form of the curves of E.M.F. of the first two named machines, under various conditions, have been shown in Lecture I. The general effect of all these experiments has been to demonstrate that when a transformer is worked off an alternator giving an E.M.F. curve with a very sharp or peaked form, the effect of this is to make the iron core loss less, and the secondary drop greater, than it is if the same transformer is worked off an alternator having a curve

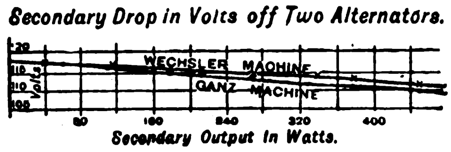

Fig. 33

of E.M.F. with a rounded or square-shouldered form. If, therefore, we draw an efficiency curve for a transformer, that efficiency curve giving the efficiency—that is to say, the ratio between the watts delivered from the secondary to the watts taken in on the transformer circuit—and express this efficiency in terms of the fractions of the secondary load of the transformer, the form of that efficiency curve will be affected by the nature of the machine which is supplying the primary current. In Figs. 31, 32, 33 are shown curves illustrating the effect of the employment of different alternators on the same transformer in affecting the efficiency, primary current values, and secondary drop of any given transformer, when taken on open secondary circuit.

For fuller information on this point the reader is referred to the treatise on the "Alternate-Current Transformer" (vol. i., chap. vi., new edition), by the present writer, which will supply more details on this question than we have space to consider here.

LEGAL INTELLIGENCE.

UNDERWRITING A SHARE ISSUE.

On Monday, in the High Court Division, before Mr. Justice Lawrance and a common jury, the case of Holophane, Limited, *v.* Hesseltine came on for hearing.

Mr. C. McCall, Q.C., who appeared, with Mr. Fox, for the plaintiff company, said the question to be decided by the Court was whether defendant was a shareholder, and should be held as liable for shares in respect of which his name stood at present upon the register. The number of shares allotted was 320, and the amount in which defendant was alleged to be liable was £240, and the Court would have to decide whether he was properly on the register, and therefore liable. The company was formed in the month of February last to purchase a patent and carry on the manufacture of gas and lamp globes, and the word which had been adopted as the title of the company was one which, according to its derivation, was perfectly clear. The globes were made so as to absorb less of the light than ordinary glass globes, or, in fact, of any other kind. That was what the patentee claimed, and there were those who believed that these globes had a great future before them. The company was registered on February 19, and early in the month of March a Mr. Smith, who was a solicitor in the City and who had acted as solicitor to the defendant, called upon him. He was then acting for the patentee, a Mr. Mygatt, and they entered into certain underwriting arrangements. Mr. Hesseltine knew perfectly well what he was about, and he was getting a commission of 15 per cent. and ran the risk of having to take up 500 shares if the public did not subscribe at all. The public subscribed only about half of the capital. During the negotiations a form of application was sent in by the defendant unsigned, and ultimately defendant received a communication stating that the public had subscribed £12,600, leaving the underwriters' liability at sixteen twenty-fifths—namely, the balance of 320. After application had been made to the defendant on several occasions to fill up an application form, and no answer having been received, application was made

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for the money due. Some correspondence ensued, and in April the 320 shares were allotted to defendant by the directors, and in the course of further correspondence defendant wrote that he objected to having the confidence trick played upon him. The defence was that the defendant had been induced to enter into the contract by misrepresentation. There was no case for the plaintiff, as no application forms had been signed by the defendant. Evidence was called, the case ultimately resolving itself into a question whether a Mr. Mygatt was authorised by the defendant to sign an application for him.

The case went over to Tuesday, and ultimately his Lordship directed a verdict for the company, and allowed leave to appeal.

WESTMINSTER AND VANCOUVER TRAMWAY COMPANY.

Last week, before the Judicial Committee of the Privy Council, the Court being constituted of Lord Hobhouse, Lord Macnaghten, Lord Davey, and Sir Richard Couch, the case of the Edison General Electric Company *v.* the Westminster and Vancouver Tramway Company, the Bank of British Columbia, and others, came on for hearing. It was an appeal from a judgment of the Supreme Court of British Columbia of January 30, 1896, affirming a decision of Mr. Justice Crease.

The Hon. Edward Blake, Q.C. (of the Canadian Bar), and Mr. John D. Crawford appeared for the appellants; Mr. C. Robinson, Q.C. (of the Canadian Bar), and Mr. Bray for the respondents, the Bank of British Columbia.

The appellants, who were the plaintiffs in the action, on behalf of themselves and other creditors of the tramway company, alleged that they had, on December 29, 1893, recovered judgment against the company for 18,470dol. and costs, and that they had been deprived of the fruits of that result by a judgment obtained on January 24, 1894, by the Bank of British Columbia against the tramway company for 261,217dol. and costs, which judgment they alleged was the result of collusion by the tramway company (then insolvent) with the bank, with intent to give the bank a preference over the other creditors. The respondents denied the collusion and the intent alleged, and stated that the judgment was given for a debt due by the tramway company to the bank and under pressure exercised by the latter. The action was tried before Mr. Justice Crease without a jury, judgment was entered for the respondents with costs, and the Supreme Court affirmed that decision.

At the close of the arguments their Lordships did not call on the learned counsel for the appellants for a reply, but said they would deliver judgment at a future sitting.

WILLANS AND ROBINSON'S PATENTS.

The petition for the prolongation of one of the Willans and Robinson patents was heard by the Judicial Committee of the Privy Council on Wednesday, the Court being constituted by Lord Watson, Lord Macnaghten, Lord Shand, Lord Davey, and Sir Richard Couch.

The patent was one granted to Peter William Willans, deceased, and Mark Heaton Robinson, dated October 14, 1882, for an invention of "improvements in high-speed engines," and consisted in the use of a cylinder containing air, in which a piston moved which was connected to the heavy moving parts in order to control them.

Mr. Moulton, Q.C., Mr. Roger Wallace, Q.C., and Mr. J. C. Graham appeared for the petitioners, Messrs. Willans and Robinson, Limited; and the Attorney-General and Mr. Sutton for the Crown.

The **Attorney-General** submitted that sufficient remuneration had been received in respect of the patent, and **Lord Watson** intimated that their Lordships were unable, on the materials before them, to come to the conclusion that the remuneration received in respect to the patent had been inadequate, and they would accordingly advise her Majesty that the petition ought to be refused.

COMPANIES' MEETINGS AND REPORTS.

CROMPTON AND CO., LIMITED.

The annual meeting of this Company was held on Monday at the Cannon-street Hotel, E C., Mr. John Trotter presiding.

The **Chairman** moved the adoption of the report and accounts. The first portion of his speech was practically a *résumé* of these, which have already been given in our last week's issue. Owing, said the speaker, to the fire at the Chelmsford works last November, by which all the books and records that were in the offices had been destroyed, it had been found impossible this year to prepare any profit and loss account. That being so, the directors had taken counsel with their advisers, and the conclusion they had come to was that the only plan that seemed feasible to adopt was to have a valuation of the shareholders' property as it stood, and make a fresh start. The freehold property had been valued by Mr. Whitmore, of Chelmsford, and the plant by their managing director, Mr. Crompton, assisted by Mr. Brunton, the works manager. The result was before the shareholders. The fire destroyed a large portion of the buildings and works at Chelmsford, as well as the stock and electric light plant. There did not seem to have been any serious, if any, loss directly in consequence of the fire; but the indirect loss to them had been very serious, the business practically stopped, and the cost of manufacturing everything was enormously increased. The effect of this was clearly shown in the balance-sheet, a sum to the debit of revenue account being shown of £10,051, which, he thought he might say, was directly traceable to the fire. It had been decided to build new works as speedily as possible, and a site for the purpose had been obtained near Chelmsford, close to their present works. The Chelmsford lighting would in the future be quite distinct from the general manufacturing business of Crompton and Co. It was also clear that works of more than one storey with heavy machinery would not do. In future they would have one storey only, so that heavy tools would not come tumbling down and doing more damage than the fire itself. The new works would be constructed, so far as possible, of uninflammable materials, and the offices would be separate. The policy of the Board in the immediate past had been to endeavour to concentrate the business and get rid of outside excrescences. Their branch at Hove had been sold, and the cooking department at Lilley-road had been reorganised and the expenditure on it cut down, and efforts had been made to dispose of it. Mr. Albright had been looking for business in Australia, and other directors had been pressing it at home. At present they had as much as they could deal with. There were several assets in the accounts which might be described as non-realisable, and there was the item of £30,000 for goodwill. He thought it would be a good thing if some scheme could be devised by which some of the items might be written down or written off, and the suspense account must be dealt with. Unless this was done he did not see how they were to pay a dividend. His colleagues agreed with him that it would be desirable to take the whole matter into serious consideration, and see if some scheme could not be formulated under which the interests of the various shareholders and the debenture-holders would be equitably dealt with.

Mr. R. E. B. Crompton seconded the resolution. The disaster that had happened to them in their fire had been pretty bad, but things might have been much worse if it had not been for the splendid efforts of their staff. In these days of close competition shareholders would appreciate the difficulty of manufacturing at a profit with their plant separated and divided in temporary premises. What had been done at Chelmsford was to lower the walls to the level of one storey and put on a temporary roof, under which they had worked up to the present. They hoped to have a considerable portion of their new works roofed in three months, and, perhaps, to begin work in part of them in four months. They had before them good prospects of work, and they had been taking orders at prices which were encouraging. Had it not been for the fire he believed they would have done well on the year, and it was a bitter disappointment to him personally to find the results of their efforts swept away.

The report and accounts were then carried unanimously.

On the motion of **Mr. Crompton**, seconded by **Mr. Tufnell, sen.**, the confirmation of the election of Mr. J. Trotter as chairman was passed, Mr. Carlton Tufnell was re-elected director, and the auditors (Messrs. J. H. Duncan and Co) were also re elected.

In moving the vote of thanks, **Mr. G. Kitchen** expressed the satisfaction of the shareholders at the intention of the Board to a face consideration of the financial state of the Company. **Mr. Slater** seconded the vote, and the proceedings ended.

CITY AND SOUTH LONDON RAILWAY COMPANY, LIMITED.

The half-yearly general meeting of this Company was held on Tuesday at Winchester House, Mr. C. Grey Mott (chairman) presiding.

The **Chairman**, in moving the adoption of the report and accounts, an abstract of which appeared in our last issue, said that their experience had shown that there was no railway in existence that could boast of more punctual, convenient, and safe working than could the Electric. He then referred to the accounts, and, beginning with the capital, remarked that during the half-year there had been received on capital account £3,000 in respect of preference shares issued, £7,531 for debenture stock, and in premiums on those shares and stock £3,780. They had spent in various new works, rolling-stock, and improvements £3,280; terminable debentures had been paid off to the amount of £8,400; they had an increased balance at the bankers of £964, and had reduced their outstanding liabilities by £1,666. The amount of capital authorised had been considerably increased, because at the last meeting they created new capital under the Act of 1893. As regarded the revenue, the receipts from passengers showed an increase of £328. There was a small decrease in season tickets, but there was an increase in parcels, rents, and sundry accounts, the net increase being £500. The expenses of maintenance, on the other hand, showed an increase of £180, due to their having charged £150 of the cost of altering King William-street Station against revenue. Locomotive and generating power showed a decrease of £250; carriage repairs an increase of £100, which with other minor charges made a net decrease of £18 in the expenditure. Their net increased receipts were £509, and the net decreased expenditure £18, making £527 to the good. They had decreased debenture interest £300, and increased preference dividend £180, and they proposed to declare an increased dividend of ¼ per cent., absorbing £780. The working expenses had been 60·02 against 61·55 last half-year, a decrease of 1½ per cent.; the receipts per train mile 2s. 2¼d., against 2s. 2¼d., showing three-tenths of 1d. improvement. The receipts per passenger were 1·87 against 1·82—the largest receipts they had had since the first half-year, when they charged a uniform 2d. These receipts were steadily growing. The locomotive expenses per train mile had been 5·80d., against 6·10d., and if they deducted

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the carriage of coal, in order to make a comparison with the large railway companies, the locomotive expenses per train mile were reduced to 4½d. With reference to the passenger traffic, the largest number they ever carried was in the June half of 1894—namely, 3,383,154. They were then so overcrowded that they raised their fares. In the June half of 1895 they carried 3,113,000, but that number had since been steadily increasing until in the past half year it rose to 3,192,000. Therefore, notwithstanding the increased fare they had been charging, the number of their passengers kept steadily increasing, and the amount received on the number carried last half-year was £24,021, whereas they only received £23,564 on the increased number carried in the June half-year of 1894. They might look forward to the time when their charges might be reduced with the very large accession of traffic they would have in the future when they got their extension opened, and so were prepared to deal with it. He considered that the future of their undertaking was very hopeful. The alteration at the King William-street Station had enabled them to run considerably more trains and to give increased accommodation, but it only afforded a temporary relief. He told them last year that they contemplated putting down a condensing plant, in order to save considerably in their fuel consumption, and it was now hoped that this would be at work in two or three months' time; but it was somewhat of a novelty in this country, and they had to proceed with it very carefully. As to the extension of the three sites it would be necessary to acquire for the Moorgate-street line, the purchase of one had been arranged for, the second was under negotiation with a prospect of its being very soon concluded, while the third was the church site, about which they had been very much harassed and put to needless expense, mainly because their opponents did not appear to know their own minds as to the Church of St. Mary Woolnoth and what should be done with it. The Bill was still before Parliament; but they hoped in the course of a few days to get some satisfactory settlement of the whole matter sanctioned by Parliament. At their last meeting the shareholders authorised the issue of 20,000 5 per cent. perpetual preference shares for the purpose of paying for this extension. These shares had been taken up since the end of the half-year on satisfactory terms. At the time he had thought that these shares would rank *pari passu* with the existing preference shares, but it was found that it could not be so, and that had not made the issue so easy. This had been accomplished on such terms that the interest on the shares would not be payable for three years from now. They would therefore have time to complete their line without the existing revenue being trenched on for dividend on the additional preference shares until the extension was open and earning money to pay it. He concluded by moving the adoption of the report.

Mr. S. Hanbury seconded the resolution.

Mr. Drake congratulated the directors on the report.

Mr. Jeffreys enquired as to the loss of season ticket holders, the increase of assessments, and the issue of debentures and preference shares. He could have wished the shareholders to have had an opportunity of taking some up.

The **Chairman**, in reply, said that the decrease in the season-ticket holders was simply the result of an alteration in the fares at one of the stations. The Company carried the passengers and got the money just the same, but some of the passengers preferred to pay daily. With regard to the question of rating, he was sorry to say that the last quinquennial valuation resulted in a considerable increase in their assessment, and although they had since appealed against the assessments and done their best to get them reduced, they had not succeeded. The matter, however, would always have the careful consideration of the Board. As to the issue referred to by Mr. Jeffreys, he did not think it would have been possible for many of the shareholders to have taken it up in the form it had been issued. It had been mainly taken by several wealthy gentlemen, who intended to hold it and not to bring it on to the market at present.

The resolution was carried unanimously.

ANGLO AMERICAN TELEGRAPH COMPANY, LIMITED.

The half-yearly general meeting of the Anglo-American Telegraph Company, Limited, took place on Friday last at Winchester House, E.C , the Marquis of Tweeddale (the chairman) presiding.

The **Chairman**, in moving the adoption of the report, an abstract of which appeared in our last issue, said the notable feature was the increase in the traffic receipts, which amounted to £11,916. This was due to the revival which had taken place in trade, and which had been going on for some time. The Presidential election campaign, no doubt, had a disturbing effect on business, and when that important matter was disposed of, and the United States' financial policy placed on a more stable basis than at present, they might look forward with confidence to an increase in their earnings. The renewal fund had now reached the respectable figure of £651,700, and the market value was, he believed, £100,000 more, so that they were making tolerably rapid progress towards the million they had so often talked of in connection with their renewal fund. He thought they might consider that they had come through the ordeal of the International Telegraph Conference satisfactorily. With reference to the litigation respecting the French cable, they would remember that the directors appealed from the decision of the French Court, which was favourable to them to a certain extent, but not sufficiently so. The Company's case was lodged last April in the Chamber of Requests of the Court of Cassation, or final Court of Appeal. The Chamber had the power of refusing to allow an appeal. The consideration of the papers rested entirely with the officials of the Court, and nothing the Company could do would expedite the hearing. The result of their operation for the half-year was the considerable increase in their dividend of 3s. per share.

Mr. F. A. Bevan (deputy-chairman) seconded the resolution.

A discussion followed, and in reply to questions the **Chairman** said he felt sure they would be able to recover the costs incurred by them in connection with the French litigation, but the object of their appeal was to recover a much larger sum. He considered that it was quite compatible with the interests of the Company that he should be chairman of the Eastern Telegraph Company also. It would tend to smooth any friction which might arise between them. Neither the Eastern Company nor the pooling companies had any interest in promoting a cable to America by the Azores. The concession for the German cable was originally very different from what it was now. They would hear nothing of it, he believed, for some years to come with the exception of the opening of the line from Germany to Spain, and this was entirely with a view of giving the Germans better communication to the East than they at present had. As to the renewal fund, one of the cables was comparatively new and strong, but the others were old, and they must look forward to the time when it would be necessary to renew them or to put in many miles of new cable. Their share in the pool depended on their maintaining three cables for certain. When governments took to subsidising cables in competition with those working on commercial principles it was a serious matter, but they could not prevent the French Government or the German Government from giving subsidies.

The resolution was ultimately carried with four dissentients.

DIRECT UNITED STATES CABLE COMPANY, LIMITED.

The ordinary general meeting of this Company was held on Tuesday at Winchester House, E.C., Mr. E. M. Underdown, Q.C., presiding.

The **Chairman**, in moving the adoption of the report, an abstract of which appeared in our last issue, said the half-year's revenue, after deducting out-payments, amounted to £42,456, as compared with £37,653 for the corresponding period of 1895. The working and other expenses, including the cost of repairs to cables, amounted to £19,692, leaving a balance of £22,764 as the net profit of the half-year. This had been appropriated in paying three quarterly interim dividends amounting to £19,730 during the financial year and a final payment of 2s. 6d. per share was now proposed, making, with the three interim dividends, 2¼ per cent. for the year. During the past year there had been an increase of nearly 13 per cent. in the revenue as against an increase of 4 per cent. in the working expenses. After referring to the death of the late chairman, Sir John Pender, Mr. Underdown added that the Company was working with the utmost friendship and co-operation with the Western Union Company, and their relations with the Anglo-American Company were extremely satisfactory. Their relations with the Government were also satisfactory. Some years ago representations were made by their late chairman to the Colonial Office as to their not getting the messages from the Bermuda company which they ought to receive, and an answer was given which he did not consider satisfactory. He was now glad to say that he believed they would in future have their proper share of the messages. They had only one cable against a total of 11, and taking all things into consideration the share they had of the traffic was a very satisfactory one. With reference to the question of the reserve fund, their cable was getting respectable from its age. It had held out in a remarkable way, but they must be prepared for contingencies. In order to retain their share in the pool, they must have a perfectly good cable, and they ought not to be contented until their reserve fund amounted to a sum which would replace their cable if it were to break down. He was glad to say that their traffic in the current half-year still continued to show improvement.

Mr. James Pender, M.P., seconded the motion.

In answer to **Mr. John Newton**, the **Chairman** stated that he had not for a moment intended to suggest that their cable was at all in an unfavourable state; its condition was so good that it could be worked duplex.

The motion was unanimously adopted, and also a resolution of sympathy with the family of Sir John Pender.

GLOBE TELEGRAPH AND TRUST COMPANY, LIMITED.

The general meeting of this Company took place on Tuesday at Winchester House, E.C., the Marquis of Tweeddale presiding.

After referring to the death of the late chairman, Sir John Pender, the **Chairman**, in moving the adoption of the report, a summary of which was given in last week's issue, stated that the receipts for the past year, after paying all expenses, had been £185,223, showing an increase of £5,758 over the receipts of the previous year. This increase was owing to the fact that they had received better dividends from several of the companies in which they held investments, so that they were able to recommend that day a dividend on the ordinary shares of 4½ per cent. for the current year, which was ⅜ per cent. better than that for the previous year. In future, interim dividends would be paid on October 31, January 31, and April 30 in each year. The reason for this was easily explained by the fact that one of the companies in which they held a considerable investment now paid its dividends about a week later than they did before. Their holding in the Anglo-American Company was very large, and a small percentage of

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increase in the dividend of that company made a considerable difference in the amount received. During the past year they had reduced some of their holdings, and had distributed the amount realised among four or five different companies. In doing this they had reinvested the proceeds in such a way as to secure for the shareholders a higher rate of dividend.

Mr. James Pender, M.P., seconded the resolution, which was carried unanimously.

NATIONAL TELEPHONE COMPANY.

The annual meeting was held yesterday afternoon at Cannon-street Hotel, Mr. J. S. Forbes in the chair.

The **Chairman** moved the adoption of the report and accounts, which we published in our last issue, and proposed a dividend at the rate of 6 per cent. per annum on the first and second preference shares, 5 per cent. on the third preference shares, and 5 per cent. on the ordinary shares, all less income tax

The motion was adopted.

A fuller report of the meeting will appear in our next issue.

BRISTOL TRAMWAYS AND CARRIAGE COMPANY, LIMITED.

The following is the report of the directors to be presented to the shareholders at the ordinary general meeting to be held at the Grand Hotel, Broad-street, Bristol, on August 6, 1896, at 1 p.m. :

The gross receipts for the half-year amount to £54,456. 14s. 9d., and the working and general expenses and renewals are £42,810. 8s 6d., leaving a net balance of £11,646. 6s. 3d , which it is proposed to appropriate as follows :

Interest on 4 per cent. mortage debenture stock ...				£1,735	13	10
Dividend at the rate of 6 per cent. per annum (free of income tax) for the half-year ended June 30 ...				7,500	0	0
Balance carried to reserve and renewal funds—viz. :						
Leased premises redemption	200	0	0			
Electrical renewals	974	5	8			
Contingencies	1,236	6	9			
				2,410	12	5
				£11,646	6	3

The receipts from the tramways department show an increase of £11,651, and the carriage department returns a decrease of £155. The total number of passengers (excluding postal riders) carried during the six months on the Company's cars and omnibuses was 8,361,163. The provisional order granted by the Board of Trade authorising the construction of tramways at and near the tramways centre, the short extension of the Kingswood tramway, and the use of electricity on the Eastville line, has been confirmed by Parliament. These tramways have been constructed, as also doublings on the Horfield and Bedminster lines ; the extension of the latter section, together with the conversion of the Eastville line, is being proceeded with. A contract has been arranged for the electrical equipment of the Eastville line, as also for the necessary additions to the plant and machinery at the St. George's power station, and the directors anticipate that these will be completed and the Eastville line worked by electric traction during the current half-year. The directors are pleased to report that the St. George and Kingswood electric line has been worked with great satisfaction to the public, who much appreciate the improved facilities and reduced fares on this portion of the Company's system. It is intended to apply in the ensuing session of Parliament for powers to use electricity on the other portions of the undertaking, as also to extend the tramways in various districts. Full details will in due course be submitted for the consideration and approval of the shareholders. In the meantime, as additional capital is necessary for carrying out the works now in progress, a resolution will be submitted at the ensuing meeting to authorise an increase in the share capital. The extent to which the shares to be created will be called up entirely depends upon the Bristol Corporation being prepared to consent to the improvement and extension of the system upon such terms as the directors can properly recommend for acceptance by the shareholders.

CHILI TELEPHONE COMPANY, LIMITED.

The report of the directors of this Company for the year ended March 31 last states that the aggregate number of subscribers at all centres at the end of the year was 4,252, as compared with 4,015 at the beginning, or a gain of 237 for the year. The gross revenue from all sources for the past year compares favourably with that of the previous one. In 1895-96 it was 619,826dol., in 1894-95 it was 555,551dol.—an increase of 64 275dol. The expenditure in Chili during the year was 384,979dol. ; in the previous year, 364,477dol.—an increase of 20,502dol. The net income in Chili from all sources was in 1895-96, 234,846dol. ; in 1894 95, 191,074dol.—an increase of 43,772dol. The average rate of exchange for the year was 17·27d., as compared with 13·61d. in the previous year, giving an increase for the year of 3·66d. Converted into sterling at these rates, the net income in 1895-6 was £16,903 and in 1894-5 £10,835, or an increase of £6,068. The increase in the value of the liquid assets over liabilities in Chili, due to the rise in exchange, amounts to £351, which has been carried to reserve. The net profit of the whole business in 1895-6 was £8,551 and in 1894-5 £6,013, an increase of £2,538. In addition to the amount mentioned, the sum of £3,295 has been carried to reserve, raising it to £15,500. The directors recommend the payment of a dividend of 4s. per share, being at the rate of 4 per cent. per annum leaving £558 to be carried forward. During the year the capital outlay in sterling was £3,833 ; the total mileage on March 31, 1896, was 6,722 miles, as against 6,420 in 1895—an increase of 302 miles. The general meeting is on August 7.

EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY, LIMITED.

Directors : James Staats Forbes, Esq (chairman), the Earl of Lichfield, Major Samuel Flood Page, Joseph Wilson Swan, Esq., F.R.S . Ernest Villiers, Esq.

Thirteenth annual report of the directors for the business year ending June 30 1896 :

The profit and loss account, after writing down considerable amounts for depreciation of plant and stock, shows a credit balance of £27,526. 12s. 9d. Providing for the interest accrued upon the £100,000 debenture stock, there remains a balance of £23,026 12s. 9d. available for distribution An interim dividend at the rate of 5 per cent. per annum having already been paid in respect of the first half-year ending December, 1895, a further payment at the rate of 5 per cent. per annum, in respect of the second half is recommended ; the balance of £5,352 14s. 9d. being carried forward. Notwithstanding the severe competition now existing in the trade, the volume of business during the past year has been larger than in any former period, but the increase in the cost of material and labour, the lowering of the sale price of many articles, and the check to the Company's manufacture consequent upon the strike at the Ponder's End Works in the early part of the book year, have necessarily somewhat adversely affected the results of the year's working. The final meeting for winding up the Swan United Electric Light Company, Limited, was held on December 17, 1895, and the liquidation thereby completed. Major Flood Page and Joseph Wilson Swan, Esq., F.R S., retire by rotation from the Board, and offer themselves for re-election. Messrs. Welton, Jones, and Co., the auditors, offer themselves for re election.

Profit and Loss Account for Year ended June 30, 1896.

Dr.	£	s.	d.
Stock on hand, July 1, 1895	95,983	11	3
Wages, purchases, etc	89,804	8	1
Salaries, directors' remuneration, rent, office expenses, insurance, income tax, general and law charges	9,762	10	1
Depreciation on plant, etc..................................	4,258	12	11
Balance	27,526	12	9
	£227,335	15	1
Cr.	£	s.	d.
Balance brought forward	3,702	5	2
Sale of lamps, fittings, royalty on holders, etc......	128,101	3	2
Interest, etc.	1,825	2	6
Stock on June 30, 1896	93,707	4	3
	£227,335	15	1

Balance Sheet, June 30, 1896.

Dr.	£	s.	d.
Share capital—17,139 A shares of £5 each, fully paid, ranking up to 5 per cent. for dividend on the amount credited as paid up, and afterwards equally, per share, with A shares partly paid	85,695	0	0
89 261 A shares, £5 each, £3 paid........................	267,783	0	0
	353 478	0	0
23,564 B shares, £5 each, fully paid......................	117,820	0	0
4½ per cent. debenture stock	100,000	0	0
Sundry credit balances	13,370	5	9
Reserve fund	82,577	2	10
Profit and loss, as per appropriation account, £27,526. 12s. 9d. ; less interim dividend, paid on February 18, 1896, £8,836. 19s. ; and interest on debentures for six months paid December 31, 1895, £2,250	16,439	13	9
	£683,685	2	4
Cr.	£	s.	d.
Cost of establishing the business, goodwill, remaining patents, etc., as per last balance-sheet	281,263	6	0
Less amount of charges over-estimated	115	12	9
	281,147	13	3
Amount of B shares of this Company, issued as *per contra*	117,820	0	0
	398,967	13	3
Manchester Edison-Swan Company, Limited, £100,000 B shares at nominal cost	12,000	0	0
Freehold and leasehold property	60 045	11	9
Plant and stock	133,779	16	4
Debtors	43,917	19	3
Investment National Telephone Company, Limited, 5 per cent. non-cumulative third preference shares at cost	25,000	0	0
Cash at bankers and in hand	9,974	1	9
	£683,685	2	4

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CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Odessa.—The Municipal Authorities will receive tenders up to August 13 for street electric lighting and for the lighting of the new prison.

Nava del Rey (Spain).—The Municipality are open to receive tenders up to August 28 for the electric lighting of Nava del Rey for a period of 20 years.

Bucharest.—Tenders are wanted by August 19 for the electric lighting of the Boulevard Coltea. Application should be made to the Mairie, at Bucharest.

Mons.—Tenders are required for the construction of an electric generating station building for the Tournai Asylum. Particulars at Brussels, rue des Augustins 17, and tenders will be received up to August 3.

Vich (Spain).—The contract will be allotted by the municipal authorities of Vich on August 17 for the electric lighting of the town for 10 years from June, 1897. The annual payment proposed is about £800.

London, E.C.—Among other stores, the Great Indian Peninsular Railway Company are ready to receive tenders by August 6 for "telegraphic materials." Particulars are obtainable at the offices, 48, Copthall-avenue, E.C.

Halifax.—Firms desiring to tender for the electric lighting and hoists at the new infirmary to be built for the Guardians of the Halifax Union must apply before August 13 to the architects, Messrs. Horsfall and Williams, George-street. and deposit two guineas with the Clerk to the Guardians, Union Offices, Halifax.

Hapton (Padiham, Lancs.).—Tenders are wanted for lighting Hapton township with electricity from September 1, 1896, to April 30, 1897, for the Parish Council. Endorsed tenders should be sent to Mr. E. O'Shaughnessy, clerk, St. Anne's-terrace, Padiham, by August 3. Full particulars can be obtained on application to the clerk at that address.

Simla (India).—The Municipality is inviting tenders for lighting by electric light for a term of years the principal thoroughfares and buildings belonging to the Municipality. Tenders must be submitted by September 1 next. Should any proposal be accepted, the Municipality will afford the successful tenderer all facilities to extend the system of lighting to private houses.

Cologne.—Tenders are required by the Municipal Authorities for the construction and working of electric tramways in the city of Cologne to an aggregate length of 20·3 kilometres (12½ miles). Specifications, plans, and particulars are obtainable for 10 marks (10s.) from der Registrateur B, des Oberbürgermeisteramt, Köln, Germany, and tenders must be in by November 6.

Madras.—Tenders are invited for the lighting by electricity of Government House, Madras, including the banqueting-hall and aide-de-camps' bungalow, and also for the lighting of Government House, Guindy, including the military secretary's bungalow. For particulars application must be made to the consulting architect to the Government, Chepauk, Madras. Tenders will be opened on November 11, 1896.

Voghera (Italy).—In view of the expiration of their contract with the local gas company in 1898, the municipal authorities of Voghera are desirous of receiving during the present year propositions for the lighting of the town either by the electric light or a mixed system of gas and electricity. The population is 16,000. Application should be made to L'Administrazione Comunale, Voghera, who will give all particulars necessary.

San Juan (Puerto Rico).—H.M. Secretary of State for Foreign Affairs has received from H.M. ambassador at Madrid a copy of a Spanish Royal Order which has appeared in the *Gazette* inviting tenders for the construction and working of a telephone system in San Juan de Puerto Rico. A deposit of 800dol. must accompany each tender, which will be considered on August 10. The copy of the Royal Order may be seen on application to the Commercial Department of the Foreign Office between the hours of 11 and 6.

Mexico.—The municipal authorities of the city of Mexico are prepared to receive proposals for the street lighting by incandescent lamps for a period of eight years. Tenders should be sent in by August 31. The Secretary of State for Foreign Affairs has received from the British Consul at Mexico a pamphlet issued by the Municipal Council of the city containing particulars as to the tenders, and this may be seen on application to the Commercial Department of the Foreign Office between the hours of 11 and 6. The plan as laid out accounts for 480 arc lamps of 2,000 c.p. each, and 120 of 1,200 c p., to which are added 150 incandescent lamps.

Southampton.—The Harbour Board invite tenders for the construction and erection of four electric cranes and accessories, and also for alterations to gantry of an existing crane, on the Town Quay, Southampton. Specification, with two general drawings attached, may be obtained on and after 20th inst. from Mr. A. H Skelton, clerk, Town Quay, Southampton, upon payment of £3. 3s., which will not be returned, and further detailed plans may be seen at the office of the electrical engineer, Mr. J. G. W. Aldridge, 9, Victoria-street, Westminster, S.W. Sealed tenders, marked "Tenders for Electric Cranes," should be sent to the clerk by August 31.

Manchester.—The Gas Committee require tenders for the construction of an underground electric lighting sub-station in Piccadilly. The general conditions of contract, bills of quantities, and forms of tender can be obtained on application in writing to Mr. C. Nickson, superintendent, Gas Department, Town Hall, Manchester. A deposit of £1 1s., which will be returned on receipt of a bona fide tender, must accompany each application for a tender form. Sealed tenders, addressed to the Chairman of the Electric Light Sub Committee, and endorsed "Tender for Underground Sub Station," must be delivered at the Gas Office, Town Hall, by 10 a.m. on August 8.

Jassy.—The Mayoralty of the Town of Jassy (Roumania) has given notice that on August 23, 1896, old style (by our reckoning September 4), tenders will be received, for the second time, in the hall of the Municipal Council, for "the installation of a frigorific hall, electric light, and various accessories requisite for new public slaughter-houses. Offers must be in accordance with the specification, the conditions of contract, the special conditions, and the plans deposited in the offices of the director of the slaughter house works, where particulars may be obtained." Tenders are to be enclosed in sealed envelopes, marked "Offre pour l'installation de la Hall Frigorifique," and senders of tenders must abide by articles 68-79 of the Roumanian Public Accounts Act. All tenders and supplementary documents must be in either the Roumanian or French language.

RESULTS OF TENDERS.

Edinburgh.—The Corporation have accepted the estimate of J. Lownie, Gilmore park, for works in connection with the addition and alteration to the central electric lighting station, amounting to £4,397.

Leeds.—In connection with the extension of the electric tramways from Roundhay to Kirkstall, the Tramways Committee have decided to recommend the Council to accept the tender of Laing, Wharton, and Down, London, the amount being £5,740.

Horsham.—The West Sussex County Council have placed the order for the wiring, fitting, and machinery in connection with the installation of the electric light at the asylum for the sum of £5,228 with Messrs. Crittall and Co., Manchester-square, London.

Shoreditch.—The Vestry have received eight tenders for the internal wiring and fitting-up of power station. The highest tender was that of Strode and Co. at £956, and the lowest that of Laing, Wharton, and Down at £428 9s. 6d. The tender of the latter was accepted.

Exeter.—The City Council have accepted the following tenders: Easton, Anderson, and Goolden, Erith, alternators, £1,320; Brush Electrical Engineering Company, three transformers of 30 kilowatt capacity and four of 10 kilowatt, £300; Babcock and Wilcox, water-tube boiler of 300 i.h.p, 140lb. pressure, £630; Fowler-Waring Cable Company, 3 650 yards of cable, £685.

Battersea.—The Electric Lighting Committee have received 35 tenders for the electric lighting of the municipal buildings, and upon the recommendation of the consulting electrical engineer, Mr. Robert Hammond, the following have been accepted by the Vestry, subject to the respective contractors entering into contracts with two sureties for the due and satisfactory execution of the work:

Spurr, Inman, and Co., Limited, boilers and accessories	£668	10	0
Johnson and Phillips engine-house plant	1,030	15	0
Laing, Wharton, and Down, main switchboard and instruments	143	0	0
Chloride Electrical Storage Syndicate, Limited, accumulators	314	0	0
A. H. Wood, Westminster, wiring and fittings	1,042	13	6

BUSINESS NOTES.

Exeter.—The City Council have decided to light Northernhay by electricity.

Sofia (Bulgaria).—It is proposed to construct a system of eight electric tramway lines for the city of Sofia.

St. James's and Pall Mall Electric Light Company.—The share transfer books will be closed to August 5 inclusive.

Calcutta.—Messrs. John King and Co. have applied for a license to supply electricity. Their application is to be considered by the Corporation shortly.

Bristol.—Colonel Marsh, R E., has held a Local Government Board enquiry into the application of the Corporation to borrow £75,000 for electric lighting purposes.

Charing Cross and Strand Electricity Supply Corporation, Limited.—Letters of allotment and regret have been posted. We are informed that the issue was subscribed for nearly four times over.

Acton.—The District Council have decided to ask Mr. Goddard and Mr. Cohen to attend before the Council with reference to Mr. Goddard's letter as to the purchase of Mr. Cohen's electric lighting works.

Direct United States Cable Company.—At the meeting of the Company it was reported that the receipts for the first half of this year were about 13 per cent. above those of the corresponding half-year.

Gloria Electrolytic Incandescent Light Company, Limited.—This Company has been formed, with a capital of £20,000, to acquire and turn to account any patents relating to improvements in lighting by gas.

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Western and Brazilian Telegraph Company.—The receipts for the week ending July 24, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, amounted to £2,695.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending July 26 amounted to £1,301, as compared with £1,197 in the corresponding week of the previous year, being an increase of £104.

Westminster Electric.—The Board of the Westminster Electric Supply Corporation, Limited, have declared an interim dividend for the half-year ended June 30 at the rate of 6 per cent. per annum, payable on September 1 next.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ending July 24 were £2,445. 6s. 8d., compared with £1,943. 7s. 3d. for the corresponding period of last year, being an increase of £501. 19s. 5d.

Calcium Carbide Company, Limited.—This Company has been formed, with a capital of £500,000, to enter into an agreement with J. C. Bayley, and to carry on business as acetylene gas generators, calcium carbide manufacturers, etc.

Wellington.—The Rural District Council have had several tenders for lighting the town by electricity, and have decided to invite further particulars from the Brush Electric Company with a view to lighting the town by electricity next year.

Stockton.—It is proposed to adopt electricity as the motive power for the tramcars, and negotiations are understood to be pending between the present company and the promoters of a new company. The cars are at present drawn by steam.

Venezuela Telephone and Electrical Appliances Company.—Coupon No. 12 from the 5 per cent. mortgage debenture due on July 31 will be paid from that date at the Consolidated Bank, Limited, and at Messrs. Westendi and Co.'s Bank, Amsterdam.

New Address.—We have received from the Boudreaux Dynamo Brush Company a notice that from August 10 their business style will be "The Dynamo Brush Company," and their address Chiswell House, Finsbury-pavement, London, E.C., instead of at Gresham-street.

Wells (Somerset).—At a special meeting of the Town Council in connection with the proposed installation of electric light, a motion to rescind the former resolutions of the Council in so far as they relate to instructing Dr. Hopkinson and the city surveyor to prepare plans was lost.

Doncaster.—Mr. Charles Fisher, of 19, Wood-street, and late of the National Electric Supply Company, of Preston, is about to put an electric light plant into operation for the supply of the electric light to the neighbourhood. The cost will be the same as gas in the first instance.

City and South London Railway.—The returns for the week ended July 26 were £813, compared with £827 for the corresponding period of last year, being a decrease of £14. The total receipts for the half-year 1896 were £3,488, compared with £3,421 last year, being an increase of £67.

The Civil List Pensions.—A parliamentary paper issued recently gives some particulars about the latest Civil List pensions. Mr. Oliver Heaviside is rewarded for "his work in connection with the theory of electricity," and Mr. Samuel Alfred Varley is given an additional pension for his electrical inventions.

Horsham.—The Visiting Committee of the West Sussex County Council reported at the last meeting that they had agreed with Messrs. Crittall and Co., of 34, North-street, Manchester-square, London, for the wiring, fittings, and machinery in connection with the installation of the electric light at the asylum for the sum of £5,228. 7s.

Waterloo-with-Seaforth.—The Urban District Council have appointed a Parliamentary Committee to deal with the district lighting question. The Chairman said it was rather an important matter, because the company wanted to get on with the building of their generating station, and till the committee was appointed they were unable to proceed.

Hornsey.—At the District Council meeting, Mr. Porrin asked if the Stroud Green-road could not be lighted by electricity by making some arrangement with the Islington Vestry, who were lighting adjoining roads with it. The Chairman: You cannot bring the electric light into Hornsey; you would be encroaching upon the Hornsey Gas Company.

Kidderminster.—In a note last week on the Kidderminster and Stourport Electric Tramways Bill it was inadvertently stated that the Bill was 14 days before the committees instead of four days. The important question was, of course, the terms on which the tramline should be permitted to cross the railway. Mr. Balfour Browne was the leading counsel for the Bill.

The Pacific Cable.—Mr. Audley Coote, the representative of the French Cable Company, states that the project for a main Pacific cable has not been lost sight of by his company, but owing to the approaching Presidential election there has been a delay in the United States in dealing with the Bills to authorise the construction of the line from San Francisco to Honolulu.

Poole.—At the meeting of the Town Council a letter was read from the Bournemouth and District Electric Supply Company, Limited, giving notice that the company intend to apply by memorial to the Board of Trade, in pursuance of the Electric Lighting Acts, for a provisional order authorising the company to supply electrical energy for public and private purposes in the borough.

Wolverhampton.—Owing to the expansion of business, the directors of Messrs. T. Parker, Limited, electrical engineers, Wednesfield-road, have decided to greatly enlarge their works. For this purpose the shareholders and their friends have subscribed the whole of the uncalled-up capital, which now stands at £75,000. It is intended to double the area of the principal workshops, in order to deal more expeditiously with the orders that are reaching the firm.

Baker-street and Waterloo Electric Railway.—Lord Morley's Committee of the House of Lords have passed the Bill sanctioning an extension of the authorised Baker-street and Waterloo Railway so as to place this railway in connection with the London terminus of the Manchester, Sheffield, and Lincolnshire Railway. For this purpose additional share and loan capital is sanctioned to the extent of £100,000. This Bill has now been sanctioned by both Houses.

Bath.—At the meeting of the Urban Sanitary Authority Alderman Sturges moved the adoption of the report of the Electric Lighting Committee with reference to the purchase of the undertaking of the electric light company. He explained that negotiations were now at an end, and all they asked for was the official seal of the authority to the agreement. Mr. Hunt seconded. He said he should like to hear when the Corporation would commence to work the business. The Mayor said that due notice would be given.

Cheltenham.—At a meeting of the Town Council the proposal for the construction of an electric tramway from Leckhampton-road, through the town to Cleeve Hill, was again brought forward. The proposal was made on behalf of Mr. Thomas Nevins, of Nevins Park, Gorey, Ireland. The town clerk was instructed to prepare a provisional agreement as between the Corporation and the promoters. The scheme was discussed some weeks ago, but was then referred back to committee, as the suggested route was considered unsuitable.

Telephone Amalgamation.—At a meeting of the Cardiff Chamber of Commerce last week, the secretary (Mr. W. R. Hawkins) read a letter from the general manager of the National Telephone Company, in reply to the suggestion to amalgamate the two telephone systems. He pointed out that questions of principle as well as detail were involved. He could not explain these by letter, but would make a personal call within a week or so. It was resolved that certain members of the Chamber should meet the manager of the Telephone Company.

Leatherhead.—At the Urban District Council meeting, Dr. Davis, referring to the communication read at the previous meeting respecting a proposed application for a provisional order empowering the introduction of the electric light into the district, asked if it were the intention of the company to obtain an Act of Parliament? The Clerk replied that no company had yet been formed, but notice was given on behalf of a company about to be formed. On the Clerk stating that the Council would receive notice of any application for a provisional order no action was taken.

Bermondsey.—The Vestry have decided to obtain estimates from six of the leading electrical engineers as to the charges each would make for reporting upon the following points: (1) Whether the supply of electricity could be advantageously undertaken by the Vestry, and at what preliminary fees; (2) what would be the best system of supply for the Vestry to adopt, and the best site for a generating station, and the capital required; (3) as to the advisability of combining a dust destructor with the station for the utilisation of heat; (4) generally on the best means of putting the scheme into operation.

Warminster.—At the meeting of the Guardians, Mr. Pullin drew attention to the number of telephone posts and lengths of wire in Upton Scudamore parish, and asked if they were assessable to the poor rate. Mr. Walker replied that the telephone was Government property, and as such could not be rated. They had tried to rate Government property in Trowbridge, but the Government would not submit to be rated, though they were willing to make an annual contribution in lieu of rates. It was decided to ascertain if a similar contribution could not be got from the Government for property in this union.

Personal.—Mr. F. Teague, Coatbridge, has been appointed resident electrical engineer to Paisley Town Council, the Council having some time ago decided to introduce electric lighting. The salary attached to the office is £200. There were about 70 applicants for the situation, of which the committee selected seven.—On the recommendation of the Electric Lighting Committee, Mr. C. H. Yeaman has been appointed assistant electrical engineer to the Islington Vestry at a salary of £160 per annum. Messrs. N. Staneland, H. Knorr, and E. Hoadley have been appointed electricians at £104 per annum.

St. Pancras—In addition to Euston-road and part of Tottenham Court-road, already lit by electricity, the following further main thoroughfares are to be lighted by arc lamps, but the lamps will be fixed beside the kerb, instead of the centre of the road as in the case of the streets mentioned: Chalk Farm-road, Kentish Town-road, Great College-street, Pancras-road, and Gray's-inn-road. It is contemplated to extend still further the public street electric lighting by providing arc lamps from and along Crowndale-road to the Highgate boundary of the parish. The demand of private consumers for the electric light and power continues to increase.

Sunderland.—The half-yearly estimate of the Corporation Committee having charge of the electric light shows that a credit

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balance of £309 is expected on the half-year's working. A circular has lately been issued calling attention to the reduction of charges from 6d. to 5d. per unit for lighting purposes and from 3½d. to 2¼d. per unit for electric motors and for heating and cooking purposes, these prices being subject to discounts that range from 2½ to 20 per cent. This document states that the electric light at 5d. a unit will be found to be only slightly dearer than gas in Sunderland, light for light, but by economy in use it is possible to bring it down to the cost of gas.

Coventry.—Mr. G. W. Willcocks, M.I.C.E., Local Government Board inspector, has held an enquiry into an application of the City Council to borrow £13,000 for further extension of the electric lighting works. Dealing with the proposed extensions, the town clerk (Mr. Hammond) said the expenditure on buildings would be £1,140. 18s. 9d., and the total capacity of the plant increased to 17,500 lights as compared with 7,500 lights The other items in the increase were £4,410 for machinery; £3,500 for mains and transformers; £559 for house services, meters, etc.; and £200 for a switchboard. The inspector afterwards visited the works. A report will be presented in due course.

Liverpool.—At the meeting of the Finance Committee, the gas inspector submitted a plan for the lighting by electricity of the plateau in front of St. George's Hall. He stated that the first cost would be £250, and the annual expense of maintenance would amount to £135 As, however, the electric light would dispense with the necessity of a number of existing gas lamps, a saving of £97 16s 9d. would thereby be effected, and the actual increased cost would therefore only be £37. 3s. 3d. per annum. Mr. Petrie (deputy chairman of the Electric Lighting Committee) stated that his committee had carefully considered the matter, and were in favour of the recommendations contained in the report.

Cambridge Electric Supply Company, Limited.—The directors announce an interim dividend at the rate of 4 per cent. per annum for the half-year ending June 30, 1896. The revenue returns for the half year show a sale of 92,682 units and receipts of £2,644. 17s. 9d, against 67,223 units and £1,964. 3s. for the corresponding period of last year. The following is the revenue of returns for June quarter, 1896: Number of units sold during quarter, 1896, 27,257, as compared with 21,436 in the corresponding period last year; number of lamps connected on June 30, 1896, 16 099. The revenue from electricity supply was £794. 19s. 11d.; 1895, £625 4s. 4d.; and from meters and other sources £70. 5s. 11d.; 1895, £60. 5s 6d —a total of £865. 5s. 10d, as compared with £685. 9s. 10d. last year.

London Lighting Extensions.—The London County Council have sanctioned applications from the Westminster Electric Supply Corporation to lay mains in Millbank street, Wood-street, Great Peter-street, Greycoat-place, Old Rochester-row, Coburg-row, Greencoat row, Francis-street, Vauxhall Bridge road, Gillingham-street, Belgrave-road, Eccleston Bridge place and street, Artillery row, Hawick-place, and Victoria street; from the Notting Hill Electric Lighting Company of intention to lay mains across Kensington-park-gardens; from the House-to-House Electric Light Supply Company to lay a low-tension main in Old Brompton-road, and high and low tension mains in Collingham-road; and from the Vestry of St. Pancras to lay mains in Crowndale road. The Vestry of Islington also gave notice of intention to lay mains in Pentonville-road, but over these works the Council have no power of approval or disapproval

Hampstead.—At the meeting of the Vestry, the Lighting Committee recommended that a Ferranti automatic device for reducing the loss on transformers be tried in one of the transformer-chambers, at a cost of £50. Mr. Reed chairman of the committee, said it was desired by the committee to save the enormous loss of electricity caused by the use of large transformers. The Ferranti automatic device had been tried in Newcastle, and the Vestry's engineer had recommended that one be tried here. The recommendation was adopted. It was decided to lay mains for the supply of electric current to private consumers in Albion-road and Antrim street. It was also decided to erect a Ferranti switchboard in the extension of the buildings at the station, at a cost of £460. 5s, in lieu of the ordinary switchboard which the Vestry resolved, on May 7 last, to erect at a cost of £150 the difference in cost being £310. 5s.

Bedminster.—A reply has been received to the letter sent by the Parish Council to the Bristol Tramways Company asking for an improvement of the tram service in the neighbourhood of Totterdown. Mr. S White, secretary of the company, said: "Your Council must, of course, appreciate the fact that, as long as we are restricted to horse traction, it would be quite impracticable to extend the tramways in the direction indicated, though, of course, it would be quite possible if a general introduction of electricity were permitted." At the meeting of the Council the Chairman said that he and Mr. A. J. Smith had approached Mr White for the purpose of finding out what the company would be willing to do in the matter. Mr White said that they would be applying for powers in the coming session of Parliament early next year for an electric system in the district. If they got their powers, they would include the Wells-road and the Bath-road.

Hull.—The Finance Committee at their last meeting renewed the discussion on the matter of the application of the Electric Lighting Committee to borrow £42,000 for electric lighting extension. The Treasurer said that, according to figures furnished him by the electrical engineer, and by calculations he had made himself with reference to interest and sinking fund, the total probable cost of the old station next year would be about £5,299, If the new station were in working order for the whole year, the cost, based on the same calculations, would be about £4,489. The total estimated expenditure was £9,786, and the total estimated receipts £9,800 leaving a balance of £14 for the year. In that calculation he had charged the whole year's interest and sinking fund, when in all probability it would not have to be paid because the works were not in hand nor likely to be. After some further discussion, the matter was adjourned to a special meeting.

Battersea (London).—At the meeting of the Vestry, Mr. Sellicks, on behalf of the Special Electric Lighting Committee, moved the adoption of certain important recommendations. These included the electrical lighting of the municipal buildings and town hall and the central library. The committee having conferred with the engineer, recommended that contracts be entered into with Messrs. Spurr, Inman and Co., Messrs. Johnson and Phillips, Messrs. Laing, Wharton, and Down, Mr A. H. Wood, and other firms, for the supply of boilers, accessories, switchboards, wiring, and fittings, etc. The work of building cutting away for wiring, making good, etc., will be carried out by men in the direct employ of the Vestry The tenders amounted to £3,198. 18s. 6d. Buildings are estimated to cost £600; cutting away and making good, etc, £200; and the engineer's fees. £200—total, £4,198. 18s 6d. It was asked that the matter be referred back to the committee, with power to carry the scheme into effect, and that application be made to the London County Council for a loan of £4,200 necessary to defray the cost of the work. The report and recommendations of the committee were adopted without discussion.

Southampton.—The Works Committee recommended at the meeting of the Town Council that they be empowered to retain the services of an expert, at a fee of not exceeding 50 guineas, to advise the Corporation on the following points: the probable life of the permanent tramway; the suitability of the permanent way for electric traction; the present value of the permanent way; estimated repairs per annum; the desirability of using overhead or underground wires for electric traction. Mr. Lemon moved the adoption of the report, explaining that they proposed to work the cars by electric traction; but if they thought this undesirable they intended to call in an expert for advice, and therefore the question of rolling stock had been left out of consideration. Alderman Button seconded the adoption of the report. Mr Le Feuvre strongly objected to the use of overhead wires in electric traction. If they were going to make £50,000 a year he would not consent to their beautiful town being spoilt by overhead wires, and he suggested that the borough engineer should not be asked to report on the desirability of overhead wires, as it would merely be a waste of energy. The report was adopted.

Edinburgh.—The directors of the music hall have just spent over £2,000 upon its redecoration and the introduction into it of the electric light. The scheme has been carried out under the direction of Dr. Rowand Anderson by Messrs. Moxon and Carfrae. A long discussion took place at the meeting of the Town Council on the report of the Electric Lighting Committee, adhering to a former recommendation for the establishment of a renewal fund. It was eventually decided "that the question as to the disposal of the moneys received from the electric light undertaking raised by the motion of Councillor Mackenzie be remitted to a joint conference of the Electric Lighting, Treasurer's, and Law Committees, with power to take the opinion of counsel." On the recommendation of the Electric Lighting Committee, it was agreed to accept the estimate of Mr. John Lownie, Gilmore Park, for works in connection with additions and alterations to the central electric lighting station amounting to £4,397. It was unanimously resolved to accept an offer by Mr. M'Ewan, M.P., to erect an ornamental electric lamp pillar in the centre of the vacant space on the east side of the M'Ewan Hall. A remit was made to the Cleaning and Lighting Committee, in preparing the estimates for the current year, "to take into consideration the requirements of an extended area as at November 1 next, inclusive of Portobello, with the view of improving the public lighting thereof"

Fulham.—At the meeting of the Vestry the Electric Light and Dust Committee reported that they had received a letter from Mr. S Marl, of 4, Fenchurch-avenue, E.C., stating that he was instructed by the County of London and Brush Provincial Electric Lighting Company, Limited of Moorgate-court, to inform them that application was intended to be made on or before December 21 next by that company by memorial to the Board of Trade, in pursuance of the Electric Lighting Acts, 1882 and 1888, for a provisional order to be confirmed in Parliament in the ensuing session whereby it is proposed to authorise the said company to apply electrical energy for public or private purposes within the area of the jurisdiction of the local authority as defined by the above Acts for the district of the parish of Fulham. A letter was also read from Mr. Charles W. Sax, of 53, Charterhouse-street, West Smithfield, asking the favour that the clerk would inform the Vestry that he intended to apply to Parliament next session for a provisional order to supply Fulham with electrical energy. On the motion of Mr. Terry, it was resolved that the Vestry oppose the granting of the provisional orders. The report of Mr. F. H. Medhurst as to the installation of the electric light in the parish and the erection of a dust destructor in connection therewith was considered, and the committee agreed to the appointment of a deputation to visit Oldham, Leeds, Warrington, Bedford, Brighton, and Portsmouth. When, however, the report was brought up at the meeting of the Vestry the chairman ruled it out of order.

Callender's Cable and Construction Company, Limited.—This Company has been formed to purchase as a going concern the business and works founded by Messrs. Callender and Sons, and carried on for the last 14 years by Callender's Bitumen Telegraph and Waterproof Company, Limited, at Erith, London, and elsewhere, together with the freehold factory, goodwill, stock-in-trade, book debts, bills, cash balance at the bank, and other

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assets, and subject to all the liabilities of the business. It is certified that the profits for the five years ending December 31, 1895, after providing for all working charges, repairs, expenses of management, and appropriating £11,500 for depreciation during that period, but without charging directors' fees or interest on debentures and loans, amounted to £68,573. 1s. 9d., being an average of £13,714 12s. 4d. per annum. The profits for 1895 forming part of the above figures after appropriating £3,000 for depreciation for that year, amounted to £16,279. 2s. 10d. The capital is £100,000 in shares of £5, the whole of which has been taken by Callender's Bitumen Telegraph and Waterproof Company, Limited, and 4½ per cent. first mortgage debenture stock for £90,000, of which £40,000 will be allotted in exchange for the debentures of that amount in Callender's Bitumen Telegraph and Waterproof Company at par, and the balance—viz., £50,000—is now offered to the public at 103. The debenture stock will be secured by a first mortgage on the freehold premises and plant, and a floating first charge on the remaining assets of the Company, and will be redeemable at the Company's option after June 30 1916, at 110 per cent.

Appointments Vacant.—The Corporation of Sunderland require the services of an electrical engineer to act as resident engineer at their electric lighting station, and to design and superintend any extensions of their station, plant, and mains. Any extensions of the station buildings will be designed and carried out after consultation with him by the borough or other engineer. A schedule of duties can be obtained from Mr. Fras. M. Bowey, town clerk, Town Hall, Sunderland. It is essential that candidates should have been properly trained both as mechanical and electrical engineers, have a full knowledge of both the three-wire continuous-current and the high-tension alternating-current system, and have had central-station experience. The candidate selected will be expected to enter upon his duties by September 1. Canvassing is prohibited. The engagement will be for four years certain from the date of the engineer entering upon his duties, subject to the option of the Corporation to determine it by three months' previous notice in writing, expiring at the end of the first year. The salary will be for the first year £300, second year £350, third and fourth years £400 per annum. Subject as above the engagement to continue after the fourth year at the salary of £400 per annum, with the right of either party to determine it at the expiration of three months' previous notice in writing. Applications, stating age, station experience, and accompanied by original testimonials, to be addressed to the town clerk, endorsed "Application for Electrical Engineer," to be delivered by August 4.—The Hammersmith Vestry have decided to invite applications for the office of resident engineer, at a commencing salary of £200, during the construction of the electric lighting works, to be increased to £250 when the installation is completed and in working order. The applications will be considered at the first meeting after the recess.

Catalogues.—We have received an illustrated catalogue from Mr. F. C. Allsop, manufacturing electrician, of 97 Queen Victoria-street, E.C., from which we gather that Mr. Allsop has in stock a large assortment of every article that an electrician may require. The catalogue is arranged in a convenient form, and the prices can be ascertained at a glance.—We have already briefly acknowledged receipt of a catalogue from Messrs. Rosling and Appleby, mechanical and electrical engineers and brassfounders, of Trafalgar Works, Bradford. This catalogue gives full particulars and prices of dynamos for running either arc or incandescent lamps, or for transmission of power; also of motors for cranes, hoists, pumping, hauling, coal-cutting, and tramway plants, etc.—Mr. A. B. Pescatore, of 5, Cross-street, Manchester, sends us a very interesting price-list of the Tudor accumulators, of which he is the sole manufacturer in the United Kingdom. He calls attention to his special type of plates for renewals, of which he has already supplied a large number, and he informs us that owing to an improvement in the manufacture of Tudor plates, he has been enabled to considerably reduce the prices; this is especially the case for stationary cells discharging at three to ten hours' rates, where the reduction in price is fully 15 per cent. The rates of maintenance are reduced in the same proportion as the prices—*i.e.*, they remain at 3½ to 6 per cent. off list price—and at the same time the guarantee given with all batteries is extended to two years. The S type of cell given in the catalogue has been specially designed for isolated installations, where smaller batteries than the ordinary stationary types S.L. and S.H. are required. The new types of portable cells have now been perfected in all their details.—We have received two catalogues from C. W. Treacher and Co., of 165, Queen Victoria-street, E.C., one of which contains useful diagrams, which will enable anyone to see how a house should be wired; and although we deprecate the growing practice of allowing inexperienced men to erect electric light installations, we think these hints will be useful as a guide to workmen. Mr. Treacher has gone fully into the telephone question, and his catalogue of instruments, wires, and accessories is most full and complete. Here again the diagrams of connections will be exceedingly useful. He has also listed a speciality for lighting an ordinary gas burner by electricity. An induction coil is used, and a spark made to pass between two points near where the gas jet is issuing.

Islington (London).—At a meeting of the Vestry a report has been received from the Electric Lighting Committee, stating that with a view to give effect to the resolution of the Vestry of May 8, 1896, it had instructed the architect, Mr. A. H. Tiltman, F.R.I.B.A., to prepare plans for the extension of the electric lighting station so as to provide accommodation for the required additional plant; submitting such plans for the inspection of the Vestry; and recommending that such plans be approved and adopted. This was agreed to. Another report was received from this committee, stating that as the agreement, dated October 7, 1893, whereby the services of Mr. Gay as electric lighting engineer where secured to the Vestry for a period of three years, at an annual salary of £400, will expire in October next it has considered the question of his reappointment with a view not only to the proper control of the existing works and station, but to the supervision of such extensions or alterations thereto as may be required from time to time; and that having regard to the very satisfactory manner in which the engineer has discharged the onerous duties which have devolved upon him during his service with the Vestry, it recommended that he be appointed electric lighting engineer during the pleasure of the Vestry, at a salary of £500 per annum, as from January 1 last, with further annual increments of £50 as from January 1, 1897, until a maximum salary of £600 is reached. The motion was agreed to. The committee also reported that, pursuant to Vestry reference of July 3, 1896, of an intended application by the County of London and Brush Provincial Electric Lighting Company, Limited, to the Board of Trade for a provisional order authorising the company to supply electrical energy within the Vestry's area; and that in connection therewith it has interviewed the company's chief engineer and solicitor, who state that the object of the proposed application is to enable the company to lay mains from Wharf road, along Frome-street and Arlington street to the New North-road, so as to form a connecting link with the parishes of Shoreditch and Hackney and also along the City road from St. Matthew's Church to the Angel Tavern, so as to form a connection with the company's mains in the parish of Clerkenwell; and recommending that the consent of the Vestry to the proposal of the company be not given, and that any application of the company to the Board of Trade for a provisional order be opposed. This was again agreed to. A report was received from the General Purposes Committee, stating that it has considered a reference from the Public Health Committee requesting that arrangements be made for establishing telephonic communication between the Vestry Hall and the shelter-house near the Vestry's disinfecting station in the Seven Sisters'-road; that in connection with the reference, it has appointed a sub-committee to consider the question; and recommending that the offer of the National Telephone Company to respectively connect the Liverpool-road depôt and the disinfecting station with the Vestry Hall by telephone, at annual rentals of £6 and £19 respectively on a three years' agreement, be accepted. The Vestry have decided to extend the mains in Goswell-road and Graham-street, City-road, at an estimated cost of £700.

The Brockie-Pell Arc Lamp, Limited.—This Company has been formed to acquire Messrs. Brockie and Pell's inventions for the construction of electric arc lamps as embodied in various patents and patent rights and all future improvements on such patents. The Company will acquire the goodwill attaching to such patents, and the business connected therewith and they will work and develop their business in connection with the several patents and patent rights and otherwise. The Company comes before the public, not as a concern to establish a connection, but with a valuable business already built up, the profits from which it is believed will yield a handsome dividend to the shareholders. The business of the Company will consist of and their revenue be derived from the manufacture and sale of the lamps and accessories, the granting of licenses, the supply of installations and plant, and the general business of electrical engineers. The manufacture and sale of the lamps and incidental business have hitherto been carried on by a firm of electrical engineers under arrangement with the patentees, who have received a royalty on the sales. The termination of that arrangement affords the directors the opportunity to make the present issue, which will provide the capital necessary to enable them to manufacture the lamps in such quantities as will supply the increasing demand and to carry on and extend the business. The sale of the lamps is an increasing one. The year 1895 showed a continued increase, whilst for the first quarter of 1896 there was an increase of more than 27 per cent. over the corresponding quarter of 1895. It is also expected that a considerable addition of profit will accrue from the active working of the European, foreign, and Colonial patents, which up to the present time have been worked to a very limited extent. The directors are of opinion that the sales of lamps alone should yield sufficient net profit to enable the Company to pay a dividend of 7½ per cent., and also that as the Company proposes to themselves manufacture the lamps, the net income derived from this source alone should suffice to raise the dividend to at least 12½ per cent., and further that the profit on the manufacture and supply of accessories, the supply of installations and plant, the profit on repairs and on incidental business, should yield a further income which should provide a total dividend of at least 17½ per cent per annum. These figures leave out of count the profits to be obtained by the working of European, foreign, and Colonial patents. Over 10,000 of the lamps have already been sold. It is claimed for them that they give a steady, white light, without the flickering or the variation common to other arc lamps; that they are very economical in carbon consumption, and as they burn 40 hours without attention or recarboning, the cost of maintenance is considerably reduced; that they work satisfactorily on either constant-current or constant-potential circuits, and with continuous, alternating, or rectified currents; and that they have very simple mechanism, consequently their working is easily understood and they keep in perfect adjustment and good order for very long periods. Sir David Salomons, Bart., and Dr. Hopkinson have reported very favourably on the lamps. The purchase-money has been fixed by the vendors at £60,000, payable £30,000 in cash, £25,000 in fully-

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paid shares, and £5,000 in cash or shares at the option of the Company. The capital is £80,000 in £1 shares.

PROVISIONAL PATENTS, 1896.

JULY 20.

16019. Improvements in regulating switches. Rookes Evelyn Bell Crompton and Edmund Arthur Norman Pochin, 55, Chancery-lane, London.

16057. Improvements in electrolytic apparatus. Carl Kellner, 46, Lincoln's-inn-fields, London.

JULY 21.

16082. Improvements for fittings in incandescent street lamps and the like. John Westwood Lee and John Hall Perrins, Midland Works, Bracebridge-street, Birmingham.

16091. Improvement in electric batteries. Adolphe Stevens and François Puttaert, 8, Rue des Princes, Brussels.

16152. Apparatus for controlling electric currents. Joachim Estrade, 18, Buckingham-street, Strand, London.

16168. Improvements in insulators. Benjamin Du Bois Smock, 40, Chancery-lane, London. (Complete specification.)

JULY 22.

16231. Improvements in electric motors and dynamos. George Seymour and Samuel Allen Letts, 60, Cleveland-gardens, Barnes, London.

16256. Improvements in electric furnaces. Louis Michel Bullier, 53, Chancery-lane, London. (Date applied for under Patents, etc , Act, 1883, Sec. 103, December 28, 1895, being date of application in France.)

16257. Improvements in electric furnaces. Louis Michel Bullier, 53, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, January 27, 1896, being date of application in France.)

16268. Improvements in electric batteries. Walter Rowbotham, 45, Southampton-buildings, Chancery-lane, London.

16270. Improvements in secondary electric batteries. Marie Oscar Armand Garreau, 45, Southampton-buildings, Chancery-lane, London.

JULY 23.

16226. Improvements in apparatus for obtaining electric discharges. Frederick William Golby, 36 Chancery-lane, London. (Alexander Vosmaer, Holland.)

16342. Improvements in or relating to prepayment mechanism for electrical or other meters. Charles Orme Bastian and Herbert Cecil Hodges, 31, Southampton-buildings, Chancery-lane, London.

16358. Improvements in or in connection with electric railways or tramways. Henry Joseph Gill, 6, Lord-street, Liverpool.

JULY 24.

16373. Improvements in the distribution of electricity, and in junction boxes for use therein. William Illingworth and Thomas Smith, 18, St. Ann's street, Manchester.

16404. Improvements in and relating to electrical signalling apparatus or bells. Samuel Jevons and William Collins, 77, Colmore-row, Birmingham.

16407. Improved means applicable for use as an "engine-room telegraph" and for other signalling purposes. Charles Ashmore Baker, 191, Fleet-street, London.

16418. Improvements in the method of and means for automatically regulating arc lamps and other electrical apparatus. Willem de Graaff, 23, Coleman-street, London. (Complete specification.)

16421. Regulator for dynamo machines. Anton Heusch and Paul Brandt, 70, Chancery-lane, London. (Complete specification.)

16435. Improvements in filaments of electric incandescent lamps. Frank Eustace Wilkins Bowen, 6, Bream's-buildings, Chancery-lane, London.

16445. Apparatus for controlling electrically-actuated railway point apparatus. Siemens Bros. and Co., Limited, 28, Southampton-buildings, Chancery-lane, London. (Siemens and Halske, Germany.)

16457. Improvements in solenoid cores for voltmeters. Paul Brandt and Anton Heusch, 31, Southampton-buildings, Chancery-lane, London. (Complete specification.)

JULY 25.

16475. Improvements in electric arc lamps. Edward Jones, Albert Edward Jones, and George Kynoch and Co., Limited, 18, Southampton-buildings, Chancery-lane, London.

16502. Improvements in and connected with electric clocks. William Whitehead, 4, Corporation-street, Manchester.

16534. Improvements in filaments for use in electric glow lamps. Frédéric de Mare, 45, Southampton-buildings, Chancery-lane, London.

16539. Improvements in the manufacture of cables for telephonic, telegraphic, electric lighting, and other electrical purposes. Phillip Ormiston and Salomon Berditschewsky Apostoloff, 53, Chancery-lane, London.

16514. Improvements in electrical switches. William James Davy, 40, Chancery-lane, London.

16516. Improvements in accumulator batteries. John Vaughan-Sherrin and Henrietta Helena Sherrin, 77, Chancery-lane, London.

16533. Improvements in filaments for electric glow lamps and in methods of manufacture of the same. Frédéric de Mare, 45, Southampton-buildings, Chancery lane, London, (Date applied for under Patents, etc., Act, 1883, Sec. 103, January 28, 1896, being date of application in France)

SPECIFICATIONS PUBLISHED.

1895.

12613. Electric railways or transport. Lorrain. (Esmond.)

12615. Electric railways or electric transport. Lorrain. (Esmond.)

12616. Electric railways or electric transport. Lorrain. (Esmond.)

12697. Automatic electric fire-alarm and indicator of heavy air in a room or other enclosed space. Harsen and Frimand.

15174. Single-phase and multiphase alternate-current motors. Atkinson.

15288. Electric clocks. Lake. (Société Anonyme La Précision.)

16247. Electric cables or conductors. Edmunds.

16248. Electric transformers and dynamo armatures. Edmunds.

17123. Linked suspensions for electroliers, electric light pendants, and the like. Hirst.

18483. Electric glow lamps. Davis.

19628. Electric burglar alarms and the like. Boult. (Damseaux.)

1896.

7896. Electrical haircutters and singers. Bell and Sloss.

8948. Electrical signalling apparatus. Lake. (Painter.)

9817. Shade for use in connection with electric incandescent lamps and the like. Bach, Lewis, and Saunders.

10096. Arc electric lamps. Mackin.

11162. Electric time alarm apparatus. Golby. (Winter.)

11417. Means for electrically connecting the rails or sections of electric railways. Brown and Huntress.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5¾-6¼
Brush Company, Ordinary	3	1-1½
—— Non. Cum., 6 per cent. Pref.	2	1⅜-1⅝
—— 4½ per cent. Debenture Stock	100	112-115
Charing Cross and Strand	5	8¼-8¾
Chelsea Electricity Company	5	7¾-8¼
—— 4½ per cent. Debentures	100	114-116
City of London, Ordinary	10	14½-15½
—— 6 per cent. Cumulative Pref.	10	16½-17½
—— 5 per cent. Debenture Stock	100	133-137
City and South London Railway, Consolidated Ordinary	100	45-47
—— 4 per cent. Debenture Stock	100	135-137
—— 5 per cent. Pref. Shares	10	14¾-15¼
County of London and Brush Provincial Co., Ordinary	10	8-9
—— 6 per cent. Cum. Pref.	10	13½ 14
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
Edison and Swan United Ordinary	3	1¾-2¼
—— 4½ per cent. Debentures	100	103-106
Electric Construction, Limited	2	1⅜-1⅝
—— 7 per cent. Cumulative Pref.	2	2½ 3
Elmore's Copper Depositing	2	⅝-⅞
Elmore's Wire Company	2	⅜-⅝
W. T. Henley's Telegraph Works, Ordinary	10	17½-18½
—— 7 per cent. Preference	10	17½-18½
—— 4½ per cent. Debentures	100	109-114
House-to-House Company, Ordinary	5	4-4½
—— 7 per cent. Preference	5	8-8½
India Rubber and Gutta Percha Works	10	22-23
—— 4½ per cent. Debentures	100	106-109
Isle of Man Electric Trams, Ordinary	1	1⅜-1⅞
—— 6 per cent. Preference	1	1⅜-1⅝
Kensington and Knightsbridge Ordinary	5	9¼-9¾
—— 6 per cent. Pref.	5	7½-8
Liverpool Electric Supply, Ordinary	5	8-8½
Liverpool Overhead Railway	10	13¾-13⅞
—— 5 per cent. Pref.	10	17⅛-17⅜
—— 4 per cent. Mortgage Debentures of £100	100	112½-114½ xd
London Electric Supply	5	⅞-1⅛
Metropolitan Electric Supply	10	13¼-13¾
—— 4½ per cent. First Mortgage Debenture Stock	100	119-123
National Telephone, Ordinary	5	7⅝-7⅞
—— 6 per cent. Cum. First Pref.	10	17-19
—— 6 per cent. Cum. Second Pref.	10	16½-17½
—— 5 per cent. Non. Cum. Third Pref.	5	6⅞-7⅛
—— 3½ per cent. Deb. Stock	100	107-110
Notting Hill Company	10	11-12
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8¼-8¾
—— £4½ shares	4½	7¼-7¾
Oriental Telephone and Electric Company	1	¾-⅞
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	105-107
Southampton Electric Company	5	4¾ 5¼
St. James's and Pall Mall, Ordinary	5	12-13
—— 7 per cent. Pref.	5	9½-10½
Telegraph Construction and Maintenance	12	39-42
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary		8-8½
Westminster Electric Supply, Ordinary	5	11-12
Yorkshire House-to-House	5	7¼-7¾

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NOTES.

Obituary.—The death is announced of Prof. Adolfo Bartoli, of the University of Pavia.

Crystal Palace.—The award of certificates at the Crystal Palace School of Practical Engineering takes place to-day (Friday), Major E. Raban presiding.

Lisbon in Darkness.—A strike of nearly all the workmen and lamplighters of the Lisbon gasworks left that city in darkness on Saturday and Sunday last. It is stated that people fell back on Chinese lanterns and candles.

The Civil Engineers.—The Institution of Civil Engineers have obtained an injunction to restrain the Institute of Civil and Mining Engineers, Limited, being registered under that title or under any similar name or title calculated to deceive the public into believing the new company to be the institution of the plaintiffs.

An Electric Boat.—According to a report from Brighton, a new Mayne electric motor rudder boat belonging to Earl de la Warr has made a trial trip to sea with fairly good results. The boat is 30ft. in length, with a beam of 6ft., and is fitted with the electric motor close to the keel. The motor is driven by accumulator cells, which fit neatly into the waist of the boat.

The Canadian Tariff.—The Judicial Committee of the Privy Council, on the appeal of the Toronto Street Railway Company from the Canadian Courts, have decided that steel tramway rails should pass as railway rails if above the weight specified in the tariff. It must be remembered that on the American continent a railway is a "railroad," and a tramway in many cases a "railway." Hence difficulties in construing the tariff clauses.

Petroleum Committee.—The report of the Select Committee on Petroleum, together with the proceedings, has been issued as a parliamentary paper. The report is as follows: "Your committee are of opinion that at this late period of the session it will not be in their power to conclude their investigation; they have, therefore, agreed to report the evidence already taken to the House, and to recommend that a committee on the same subject should be appointed early in the next session of Parliament."

Australian Telegraphs.—An unprecedented event in the history of Australian telegraphy occurred on June 22, when telegraphic communication by every route from Melbourne to Sydney was completely interrupted through a heavy snowstorm which occurred over a wide area beyond Yass during the early hours of the morning, and brought all the lines down. The curious thing about the interruptions of these Trans-Australian lines is that they never seem to get into the official list issued from Berne every month.

Motorcarts.—Mr. G. T. Holloway has called attention to difficulties which may occur under the present law (even as amended by the new Act) with oil motorcarts if oils flashing below 73deg. F. are used. This, of course, covers all benzine motors. It may be said that the Secretary of State is empowered by the Act to make such regulations as he sees fit, to permit the use of such low-flash oils, but whether, as is suggested, he will be able or willing to overrule the regulations of the local authorities as to storage is at least doubtful. These, of course, vary from place to place.

Lightning.—During a thunderstorm on July 29, the Italian coast defence armour-clad vessel "Roma" was struck by lightning and set on fire. As the flames seemed likely to reach the powder magazine, and also threatened to attack the coast defence armour-clad vessel "Palestro," which was filled with explosives, it was found necessary to sink the "Roma" by means of two torpedoes. One would have thought that an armour-clad vessel with presumably iron masts going down to the kelson, and almost certainly iron standing rigging, was about as safe a thing in a thunderstorm as could well be.

Electric Fans. — Our contemporary the *Engineer* suggests doing away with windsails on board steamers entirely, and substituting electric fans. In warships the fan ought to be placed where room can be found for it low down in the ship—far below the water-line. An electrically-driven horizontal fan, with its motor, can be got into the thickness of a deck with its beams, if needs be. This would clearly be better than depending on a flimsy construction, which would certainly be greatly damaged, if not entirely shot away in action. If clear decks are wanted, the windsail is about as inconvenient as it is ugly, and that is saying a great deal.

Research Scholarships.—Her Majesty's Commissioners for the Exhibition of 1851 have made the following appointments to Science Research Scholarships for the year 1896: William Craig Henderson, M.A., B.Sc.. Alexander Ogg, M.A., B.Sc., Thomas Slater Price, B.Sc., Emily Comber Fortey, B.Sc., Harry Medforth Dawson, B.Sc., Henry Edward Annett, M.B., Joseph Ernest Petavel, John Leathart Heinke, B.Sc., John Armstrong Smythe, B.Sc., George Blackford Bryan, B.Sc., Spencer William Richardson, B.Sc., David Williams, John Henry, M.A., B.Eng., A. M. Scott, Douglas McIntosh, B.Sc., John Angus Erskine, M.A. The scholars are to devote themselves exclusively to study and research in some branch of science the extension of which is important to the industries of the country.

The Light Railways Bill.—In the House of Commons on Monday Mr. Elliott Lees asked the President of the Board of Trade whether his attention had been called to the danger of injury being done to existing electric lighting undertakings if electric railways should be constructed under the Light Railways Bill, unless the regulations now prescribed by the Board of Trade with regard to electric traction were amended so as to include precautions to prevent the currents of existing electric lighting undertakings being affected by the currents of electric railways; and whether he was prepared to amend these regulations. Mr. Ritchie replied that it would be the duty of the Board of Trade to see that there was inserted in the order authorising a light railway proposed to be worked electrically, such provisions to secure public safety and the interests of electric lighting or other undertakings as they might deem advisable. If it was necessary to amend the existing regulations, they could be amended in the order.

The Brand New System of Electric Traction.—The paper on the above subject is found elsewhere in this issue. It was read before the Tramways Institute, and consists mainly of a reprint from a patent specification. We have left the patent claims out as being rather redundant after the paper. We only trust that the bad science and grammar in the paper have not passed the fatherly supervision of the Patent Office staff. The assertion that "the earth is at all times a great induction magnet constantly tending to rob a naked conductor of the electric fluid," is too new to pass without comment. After reading this, we cannot wonder that the paper shows a general want of knowledge of electrical subjects. Thus the system, in spite of all the claims, is no

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better in respect to electrolysis effects than those now in daily practice. The complications involved in the equipment of the conduit and the mechanical plungers are such as to cause an excessive first cost. Besides this, the system would be highly dangerous to the general traffic, we think even more so than the "death-dealing trolley."

Street-Lighting.—The method of placing arc lamps in the centre of a wide street gives a good distribution of light, and at the same time a pleasing effect. This necessitates a refuge round the base of the lamp, which is also a great convenience for foot passengers. A new aspect of the case has, however, arisen at Islington, where, to save expense, the lamp on one of these refuges has been switched out at a certain hour each night. No less than three hansom cabs have collided with the obstruction caused in Upper-street. The first case was tried at the Clerkenwell County Court, and the judge held that the Vestry had a perfect right to extinguish the lamp. The jury, taking, perhaps, the common-sense view of the matter, gave a verdict for the cabby, which the judge did not allow. As the case is under appeal, further comment would be out of place at present. From the recommendation of the Electric Lighting Committee to the Vestry, which comes up for consideration to-day, we see that the Vestry is advised to stick to its guns. We would suggest that a few incandescent lamps grouped round the lamp column would be the best way to check the series of accidents.

Mining Engineers.—The annual general meeting of the members of the North of England Institute of Mining and Mechanical Engineers was held in the Wood Memorial Hall, Newcastle-on-Tyne, on Saturday. The president, Mr. Thomas Douglas, in his address, said: as to the questions which were engaging their attention they had still a great deal to learn regarding coal dust in mines. There were still differences of opinion amongst them regarding the matter, and it amounted to this, that they would have to have much more reliable information regarding the mode in which men met their death than they had had. Then there was electricity that had engaged their attention. As to its introduction into mines, the fear of danger arising from the emitting of sparks was for the moment a reasonable one. He did not believe, however, for a moment that their scientific knowledge would not find a remedy for this, and as he was persuaded that electricity was the coming power he was quite sure that its introduction with safety into the operations of mining would be an important and beneficial change. The financial report showed a surplus of income over expenditure, and there has been an increase of membership.

The Institution of Mechanical Engineers.—The summer meeting of the Mechanical Engineers at Belfast last week was a most successful one. The papers read were interesting, and the several functions conduced to the mutual introduction of the members. The annual dinner was given at the Grand Central Hotel. In answering to the toast of "The Institution of Mechanical Engineers," the President (Mr. E. Windsor Richards) said he was very proud of the position to which he had been elected. The institute was, he was glad to say, in a very flourishing condition. There were a great number of engineers seeking admission, but they were very careful in electing anyone, as they must fulfil the obligations which the council exacted. He might mention, for the benefit of the members, that, owing to strike and other difficulties, their house in St. James's Park had been delayed in building, but they hoped in the course of a year or so to have it open. The Belfast meeting had been one of the most successful and pleasant ever held by the institution, and if it were possible, he would use stronger words than he had already used in thanking the people of Belfast for their warm reception.

Trinidade.—It is announced in the Lisbon newspapers that the British Government has finally recognised the sovereignty of Brazil over the islet of Trinidade. (This spelling is the preferable one for several reasons.) If the news is correct, it is to be regretted. The Brazilian Republic, which has a great deal more territory on hand than it can manage, had no better claim to the islet than anybody else. It has been taken possession of at different times by various countries and subsequently abandoned as absolutely useless, which, indeed, it is except for the purpose of a submarine cable station. It is to the interest, not only of Great Britain, but to the whole of Europe, that its telegraphic communication with the greater part of South America should be as little as possible at the mercy of states that are frequently at variance with each other, and particularly liable to revolutions and internal disturbance. Trinidade would have served admirably to bridge the long gap between Ascension and the Plate, and even if there is no immediate prospect of a direct cable being laid, the abandonment of the islet to Brazil is one of those surrenders which are incomprehensible to outsiders. Some day the security of our commerce round the Horn and our colony of the Falkland Islands may prove to be appreciably lessened by it.

Calcutta Corporation and Cables.—Our contemporary *Indian Engineering* in a recent issue criticises editorially in no feeble manner a report by a professor on the question of what electric cables should be used for arc lighting in Calcutta. We wish we could have a copy of the report of the professor to read with the remarks of his critic to give us an insight into the points referred to. The main points of difference between the professor and editor appear to be that of the use of overhead wires, the wording of the report, and the methods of testing. The professor recommends that "every main shall be tested for insulation, the testing pressure being 200 volts" (the working pressure may rise to about 1,000 volts). From the above the editor concludes that the professor "is evidently unaware of the facts that firstly the current rating of underground cables depends either upon tension losses or upon the temperature of the soil through which they are laid; and is practically independent of their insulation; and secondly the works test to which such cables are put is usually 1·5 times their working tension, the B.T. test pressure when laid 100 volts." After reading the above we had to give up the idea of adjudication in the matter of either grammatical construction or technical knowledge.

A Ring Lamp.—In *L'Elettricità* there has been figured and described a rather curious and, so far as the writer knows, novel shape of incandescent lamp which has been brought out by the Ediswan Company. Instead of the ordinary more or less pear-shaped bulb, the lamp takes the form of a long glass tube bent round into a circle. There are four filaments, each one covering a quadrant of the circle, and these are kept in the centre of the tube by four loops. So far as can be judged by the illustration, the lamp requires five connections to feed it—*i.e.*, two positive and three negative, or, conversely, since the ends of the glass tube meeting make what would be the fourth connection a double one. If, however, the voltage were high enough, there appears nothing to prevent these last two connections being alone used and the current sent all round the ring, instead of along a quarter of the circle only. On these points the description in our contemporary gives no information. It, however, states that this form of lamp will be particularly

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adapted for theatrical use, and to be worn on the heads of dancers or fairies. Since it would supply a means of representing the aureola about the heads of saints, it is further considered that the lamp would be effective in religious ceremonies and processions.

Alternate-Current Motors.—Prof. Dugald Jackson has recently read a paper on the above subject before the North-Western Electrical Association in America. He gives the results of tests of a series of alternate-current motors, both for multiphase and single-phase work, and states that four out of the six motors tested affected the incandescent service disastrously. They show, in the professor's opinion, the absurdity of attempting with them a combined light and power service on the same circuit. The conclusions of the matter as it now stands, in the professor's estimation, are as follows. If you have a 500-volt continuous-current power service, stick to it. If you can develop a large power service within a radius of two miles from the station, put in a 500-volt continuous-service outfit. If you can develop a small power service only, which cannot afford a duplication of apparatus, or your distances are excessive, then arrange to use alternate-current motors. In this case arrange to operate all the lamps on one phase to avoid, as far as possible, difficulty of regulation, and use such a generator and system of lines as will enable the use of motors. Motors intended for use should have a high power factor, and should start without taking an excessive current from the lines. With motors, recording wattmeters must be used. This summation of leading principles by the professors is based on the assumption that uniformity of pressure at the lamps is valued by all central-station men. We shall reproduce the tests shortly, and in the meanwhile leave our readers to wonder what alteration would be made in the above conclusions if the two satisfactory motors out of the six were to be employed.

Armature Torque.—Mr. T. Wolcott, in the *American Electrician*, considers the question, Is it the attraction between the field magnets and the iron core of a motor that gives rise to the useful torque, or is it the attraction between the field and the armature conductors, or between the field and the current in the armature conductors? The author proceeds to treat the question generally, but, unfortunately, he does not take practical examples. Hence his conclusion can only be approximate, as, for instance, any comparison between the old Siemens H armature and the modern toothed core armature. The final paragraph reads as follows: "A part of the torque even in a smooth-cored armature is due to ferric attraction, but this part is probably very small, and experience proves that nearly all the strain is on the conductors direct, for there is a strong tendency of the conductors to slide upon the core. In conclusion, it may be said that there are two distinct actions tending to produce torque. First, the direct action of a magnetic field on a conductor carrying a current tending to move it across the lines of magnetic induction, but not to attract or repel it. Second, the magnetic attraction and repulsion between the field poles and parts of the armature core, which attractions and repulsions, although due to the currents in the armature conductors, do not necessarily involve any mechanical strain on the conductors, though under certain circumstances they may do so. Both of these actions may and do exist in the same motor, but in motors having smooth armature cores the first is the principal one, the second being of no practical importance, while in motors having toothed armature cores the reverse is the case—that is, the direct attraction of the teeth by the field poles is the chief source of torque."

"The Scientific American."—This journal celebrated last week its fiftieth anniversary, and its issue for July 25 is enlarged to 64 pages to commemorate the event. On the first page of this number there are reproduced on a smaller scale the fac-simile of pages in the first issue, dated 1845. The following note on one page shows the state of telegraph work at that date: "Morse telegraph—This wonder of the age, which has for several months past been in operation between Washington and Baltimore, appears likely to come into general use through the length and breadth of our land. Arrangements are already made for extending the lines to Philadelphia, New York, Albany, Buffalo, Springfield, Boston, and various other cities and sections. Hon. Amos Kendall, ex-Postmaster-General, has taken the management of the invention—whether as proprietor or agent we are not informed—while the inventor is on a tour to Russia. We shall take an early opportunity to give our readers a full and minute description of this invention, with explanations and illustrations of its principles; but in consequence of the press and variety of matter which presses on this our first number, we are constrained to defer it. We will add the remark, however, that it is contemplated by the merchants of our Western States to communicate their orders for goods, etc., by means of the telegraph, instead of abiding the slow and tedious progress of railroad cars." Smith's electromagnetic machine for medical purposes is also described and illustrated, and a note at the end of the description states that "these machines, finished in elegant style, will be furnished at the low price of 7dol. 50 cents at this office." The rest of the paper is devoted to a series of reviews of progress made during the last 50 years in the various arts and sciences.

Hot Bearings.—The following, which is from our New York contemporary, the *Electrical World*, may be of interest as embodying American practice and views of one of the causes of temporary breakdowns: "In small central stations, particularly where one or more jack shafts are employed, overheating of the bearings become a serious matter, often resulting in the necessity of shutting down the portion of the plant directly affected. Most engineers prefer to ruin their machinery, if by so doing a shut down can be avoided. The common practice in cases where the bearings become hot is to freely apply water, and, if possible, ice, and at the same time sufficiently lubricate to reduce the friction The use of water on dynamo bearings is, however, a dangerous proceeding, owing to the liability of injuring the armatnre. Ice, while more easily handled, is not always obtainable, and is likely to produce the same harmful results. The continuous use of water on bearings is never desirable, although sometimes necessary, as in the case of marine engines. It is owing, however, to occasional necessity that precautionary measures should be adopted and provision made for its use. This can be done by so casting the bearing shells that numerous passages, broad and flat in cross-section, would surround the journal. The entrance to these passages could be fitted with appropriate threaded nipples which would permit of the ready attachment of an ordinary hose, and thus water could be rapidly forced through when the bearing heats seriously. The same device is now successfully used on friction brakes where far more heat is developed than in the ordinary bearing, even one of the largest size, and yet the rubbing surfaces of the brake are kept so cool that they may be made of wood and at the same time be very durable. Such construction would not greatly increase the cost of a bearing, and yet would reduce to a minimum the chances of overheating.

Police-Calls.—Mr. Henry Norman, of Grosvenor-road, S.W., has written to the *Times* saying that one night last week he walked home and found his housekeeper guarding the premises with a tomahawk which once belonged to Sitting

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Bull, and which ought to have formed part of an Indian trophy in Mr. Norman's hall. She informed that gentleman that five burglars had been trying to force their way into the backs of the two houses next door. Mr. Norman adds, "One point in this connection is of public interest. In common with many other people I have an electric call-box in my house, for which I pay a guinea a year, by means of which I am supposed to be able to summon the fire brigade, a doctor, and the police; and the District Messenger Service and News Company, Limited, make a great point in their circulars of the importance of such facilities. Last night my housekeeper immediately rang the police-call. More than 15 minutes later a messenger boy put in an appearance to enquire what was wanted, vouchsafing the explanation that they did not answer the police-calls as the boxes were often 'messed about.' The call-box is extremely useful for summoning messengers or cabs, but if this experience I have described is the result of the company's instructions, and not the freak of an individual subordinate, it is well that the large number of people who have these call-boxes should know that in the matter of police, at any rate, they are leaning upon a reed." On the same subject Mr. Cumming Macdona, M.P., writes: "Upon reading Mr. Henry Norman's interesting letter I felt I must test the indicator in my house, and forthwith turned the point to 'policeman,' and in due course appeared the ordinary little boy asking what I wanted. I had a yearning to try the 'fire-engine,' but fearing too big a crowd might on Bank Holiday result had the notice 'caught on.'" The "ordinary little boy" is hardly an efficient substitute for a policeman, but there are very possibly two sides to the question, as the company are not supposed to keep a supply of police constables in stock at their offices.

Communication Between Railway Carriages.—Sir Courtenay Boyle, on behalf of the Railway Department of the Board of Trade, has addressed a letter to the secretary of the Railway Association on the subject of the recent outrage on the Brighton line. He states that the Board of Trade feel assured that both the directors and the officers of the railway companies would gladly take any measures which would be likely to prevent such assaults, and invites the Railway Association to be good enough to take the subject into serious consideration, and favour the Department with the result of their deliberations. A member of the House of Commons had suggested the desirability of making such alterations in the structure of carriage compartments as would prevent the perpetration of these outrages. It is possible that this pointed to the substitution of the corridor car for the ordinary railway carriage. The Board of Trade are aware that railway companies interested in long-distance traffic have this subject under their consideration, and that on general grounds for the comfort and convenience of the travelling public they are building and bringing into use corridor cars and corridor trains. The Department is not aware, however, whether the companies propose gradually to supersede the ordinary form of railway carriage by the introduction of cars for short-distance as well as long-distance traffic. Until corridor cars become general for long-distance traffic, or, at any rate, on trains running considerable distances without stopping, the question of the improvement of the means of communication between the passengers and the servants of the company in charge of the train must remain an important subject for consideration, and the Board will be glad to know whether the companies have recently made experiments with electrical or other means of communication, and, if so, with what results. We trust that the matter will be well ventilated, and feel sure that the adoption of an electric system rather than that of the cord now so much used would be appreciated by the public. The point at which the signalling apparatus is to be handled should certainly be inside the carriage, and should be so arranged that a violent wrench in any direction should give the signal to the guard.

Smoke Prevention.—The Committee for Testing Smoke-Preventing Appliances have issued a report. This committee was made up of Sir Frederick Abel, Sir Isaac Lowthian Bell, Mr. R. Forbes Carpenter, Sir Douglas Galton, Dr. J. H. Gladstone, Sir W. H. Houldsworth, Mr. A. Vernon Harcourt, Mr. J. W. Holden, Prof. Oliver Lodge, Lord Rayleigh, Prof. Roberts-Austen, Sir Robert Rawlinson, Sir H. E. Roscoe, and other experts, many Northern manufacturers, several North-country mayors, a couple of bishops, and a sprinkling of lords, including Lord Derby and the Duke of Westminster. Mr. A. E. Fletcher was the chairman. They enlisted the services of Prof. A. B. Kennedy, under whose supervision a number of tests were made near London. Afterwards it was determined to bring the testing apparatus from London, and the hon. secretary (Mr. Herbert Fletcher, of Bolton) undertook to superintend the engineering portion of the tests, while the chairman (Mr. A. E. Fletcher) undertook the chemical part of the work. The committee have been disappointed at the smallness of the support they received from steam users, in whose interests the work was undertaken. In their report the committee express their conviction that in the great majority of cases the black smoke thrown into the air during the combustion of coal is preventible, either by hand or mechanical firing, and without great cost to the consumer. Often the prevention of smoke is accompanied with a saving of expense. (It will be noted that the committee do not guarantee that it is always or even generally so.) Where firebars have an automatic reciprocating motion, an inferior and cheaper quality of coal can be used. From a perusal of the tables appended to the report it appears that the consumption of fuel was lower in boilers fired by machine than in those fired by hand, other conditions remaining equal, but the committee naturally avoid naming for recommendation any of the various appliances. Under the existing law—the Public Health Act of 1875—the action of discharging black smoke is made criminal, so that it remains only that the law shall be so far supported by public opinion that its application may be more general. In view of the fact that black smoke continues, nevertheless, to be discharged, it would have been interesting if the committee had been able to state how far the *a priori* conclusion that smoke consumption must necessarily be attended by increased economy in working was actually justified by experience.

Sir William Grove.—It is with regret that we record the death of Sir William Grove at his residence in Harley-street on Saturday last. Sir William Grove was born at Swansea in 1811, and was consequently in his eighty-sixth year at the time of his death. He was an Oxford man—his degree dates from 1830—and in those days Oxford was one of the most unpromising places in the world for a man of science to issue from, and that combined with the rarity of a great lawyer being eminent outside his own profession makes the position of Sir William Grove and the work done by him in the world of science the more remarkable. So usual is this that his scientific work was even at times forgotten by counsel, and on at least one occasion Mr. Justice Grove had to listen to arguments showing the practical impossibility of making small measurements—small measurements which were not more than a hundred times larger than ones he had constantly made himself. Mr. Grove was called to

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the Bar in 1835, and his electrical researches date from the next few years. It is difficult to realise the state of things in those days, when the conservation of energy was not axiomatic, electric measurements were made anyhow or not at all, and men spoke vaguely of "coupling up for quantity or intensity." In 1839 Grove brought out his battery, the value of which to electrical progress in those days before the dynamo can hardly be over-rated. Next year he was appointed professor of experimental philosophy at the Royal Institution, a post which he occupied for seven years. There in the course of a series of lectures he advanced the doctrine of the convertibility of the various natural forces, which afterwards resulted in the publication in 1846 of the "Correlation of the Physical Forces." About this time Mr. Grove was elected a Fellow of the Royal Society, and in 1847 obtained the Royal Society medal for his Bakerian lecture on voltaic ignition and on the decomposition of water. In 1866 he was president of the British Association at Nottingham, the subject of his address being "The Continuity of Natural Phenomena." As late as March, 1891, he made a noteworthy speech at the Chemical Society's jubilee, and, so far as his judicial work permitted, he was always constant to the Royal Institution. Of the legal side of his history it need only be said that in 1871, according to the English practice, the flourishing advocate crowned his career by being made a judge. He retired from the Bench in 1887, after 16 years' service. He was a member of the academies of Rome and Turin, and Oxford in 1875 conferred upon him the distinction of an honorary degree. Sir William Grove married in 1837 a daughter of Mr. J. D. Powles, and leaves sons and grandsons to regret him.

The Institution of Junior Engineers.—The summer meeting of the above society has been arranged to commence on 14th inst., when the members proceed to Scotland. As will be noticed from the adjoining programme, those who join the meeting must be on business bent. Only one day is given solely to pleasure excursions, and a large number of works will be open for inspection. There is no better way of gaining experience than by visiting works in progress and manufacturing firms. The following is the outline programme: Friday evening, August 14—Saloon carriage and other reserved accommodation by train leaving St. Pancras, for conveyance of members attending the meeting from London. Saturday and Sunday—Edinburgh. Visit places of popular interest, including the Castle, Holyrood Palace, Arthur's Seat, etc. The gasworks and electric lighting stations may also be seen. Monday—Visit the Forth Bridge, through facilities afforded by the Forth Bridge Railway Company. In the evening proceed to Glasgow. Tuesday—In the morning the following works in Glasgow will be open for visiting, the selection being left with the members, who are requested to inform the secretary which works they intend to visit: hydraulic pumping station; new Howe Machine Company's cycle works; Mr. J. White's optical, nautical, electrical, telegraphic, and surveying instruments factory; sewage purification works; Messrs. Neilson and Co.'s locomotive works, Springburn. In the afternoon the members will be received in the Municipal Buildings by the Hon. the Lord Provost and the Corporation, afterwards being entertained to an excursion to visit one of the new reservoirs of the Glasgow Corporation waterworks. Wednesday—Excursion to Dumbarton. Reception by the Provost and Town Council, by whom the members are also invited to drive round the historic portions of the town. Luncheon at the Leven Shipyard, by invitation of Messrs. Denny. In the afternoon inspect their various works, experimental tank, etc. Thursday—Steamer excursion on the Clyde or on Loch Lomond. Friday—The following works will be open for visiting, the selection being left with the members, who are requested to inform the secretary which works they intend to visit: Singer Manufacturing Company's sewing-machine works, Kilbowie; Caledonian Railway locomotive works, St. Rollox; Fairfield Shipbuilding and Engineering Company's works, Govan; Messrs. Mavor and Coulson's electrical engineering works, Glasgow; Glasgow Iron and Steel Company's works, Wishaw. In the evening the institution's summer dinner will be held at the Alexandra Hotel, Glasgow, the president, Mr. Archibald Denny, in the chair, and the Right Hon. Lord Kelvin the guest of the evening. Saturday, August 22—Visit in the morning Dawsholm gasworks or the electric lighting station, Glasgow. In the afternoon, train, with reserved accommodation, returns to St. Pancras, arriving at 10.45 p.m.

Fire Calls.—The Post Office authorities have been giving trouble on the subject of fire-alarm calls. Some time ago they objected to the private telegraph set up for their own use by the Ashford fire brigade, and the result has been one of Mr. Henniker-Heaton's long and categorical questions in the House of Commons. Last week that gentleman said he would ask the Secretary to the Treasury (Mr. Hanbury), as representing the Postmaster-General, "whether he is aware that communication had been established by means of electric bell circuits between the fire station at Ashford and the residences of the officers and members of the brigade, and also between the fire station and the police station; that, similarly, electric bell communication has been established between a very large number of fire brigade stations throughout the kingdom and the residences of their members and the local police stations; and that such communication is maintained without charge solely for the purpose of facilitating the prompt extinction of fire and the saving of life and property; whether the postal authorities in March last gave notice to the fire brigade at Ashford, and to the other fire brigades above referred to, that the use of electric bell communication for the purposes aforesaid was an infringement of the Postmaster-General's exclusive telegraphic rights under the Telegraph Act of 1869, 32 and 33 Vic., c. 73, and further stated that the Department was prepared to undertake the provision of such circuits; whether he is aware that the electric bell communication referred to is employed without charge for transmission, and that the Department could in no case derive any profit from it; and whether, if advised that a technical breach of his telegraphic rights has occurred in these cases, he will, nevertheless, waive his rights in the matter and remit all fines and penalties incurred; or, if this should be impossible, introduce a short Bill enabling him to do so?" The Secretary to the Treasury's answer was: "The Postmaster-General is aware of the existence of the communications referred to in the first paragraph of the hon. Member's question. He is also aware that the object of such communications is to facilitate the prompt extinction of fires and the saving of life and property, and that at Ashford, and, as a rule, elsewhere, no charge is made for their use. It is the fact that the notice referred to in the second paragraph was given in the case of Ashford. The Postmaster-General is advised that the telegraphs which have been provided at Ashford constitute an infringement of his exclusive rights, but it is not a case in which he would think of imposing onerous conditions, or of exacting fines and penalties, and he has no doubt that the matter can be suitably arranged with the local authorities." If so, what outside the domains of red-tape was the good of worrying the local authorities on the subject. A somewhat similar communication to the Ashford one has formed the subject of discussion in the Kingston-on-Thames Town Council.

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RAILWAY BLOCK SIGNALLING.

BY J. PIGG.

(Continued from page 96.)

SIGNAL LIGHT INDICATORS.

During darkness the arm of a signal-post is replaced as a signal to drivers by a light which is invariably red for "danger," and is green or white when the line is clear for an oncoming train. Where signals are at a distance from the cabin and the back lights are not visible, the existence of the light is indicated.

The apparatus employed for this purpose is of a simple character, and is shown by Fig. 31. It consists of an expansion bar, *a*, formed of an iron rod passing through a copper tube which is fixed above the flame of the lamp.

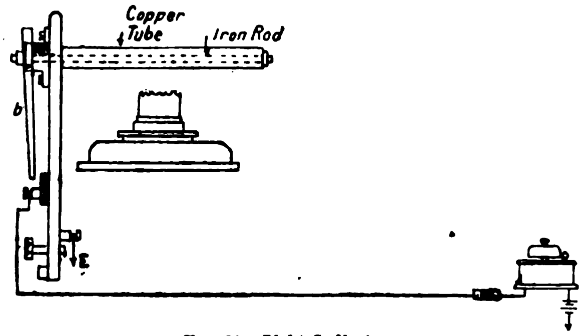

FIG. 31.—Light Indicator.

The difference in the coefficients of expansion of iron and copper cause the former to exert a pull on the short end of the lever, *b*, and separates the contact points. The expansion bar is connected to a small make and break bell and battery placed in the cabin by a special wire. If the light goes out from any cause, the expansion bar cools, and the bar, *b*, is brought into contact with the terminal base, and the bell begins to ring and will continue to do so until the light is re-established. A small peg switch is provided, so that the circuit may be disconnected during the time the lamp is not alight.

In other cases the bell is supplemented by an indicator showing "Light in" and "Light out." The "Light in" signal is maintained by a continuous current, and the indicator circuit is arranged as a shunt on the bell connections, as shown in Fig. 31A. In this way the bell is rendered silent during the time the indicator shows "Light in"; but should the light go out or anything occur to

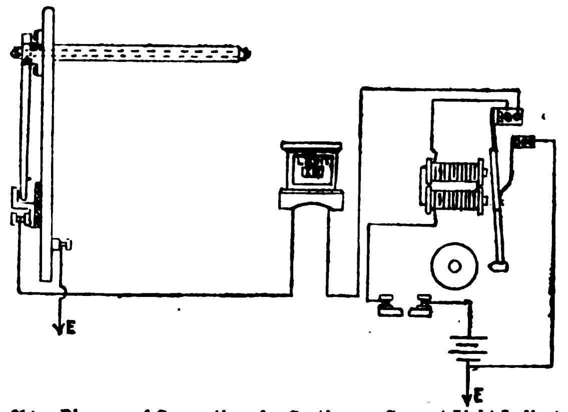

FIG. 31A.—Diagram of Connections for Continuous Current Light Indicator.

nterrupt the circuit, the continuous ringing of the bell draws the signalman's attention to the new position of the indicator.

"DISTANT" SIGNAL LIGHTS.

The form of the arm of a "distant" signal is slightly different to that of "home" or "advance" signals in being cut at the outer end, as shown in Fig. 27. This difference in form is made in order that the difference in the signals may be more easily identified, and to accentuate the difference existing in the character of these signals. "Distant" signals are passed whether "off" or "on"; "home" or "advance" signals must not be passed under ordinary circumstances when "on." The two latter signals are essentially "stop" signals; the former is not.

In order that a similar distinction may exist between the lights of "distant" and other signals the apparatus shown by Fig. 32 is being introduced by Messrs. Stevens and Sons, the railway signal engineers, for the purpose of changing the fixed light now in use to one of a "flashing" character. The lamp is of the usual construction, but in front of the light is placed a circular disc, *a*, to which an

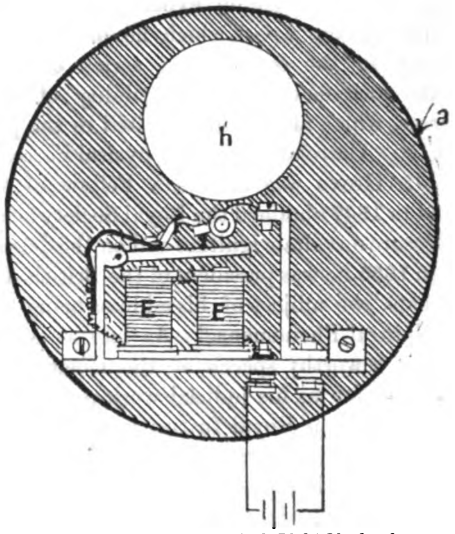

FIG. 32.—Distant Signal Flash Light Mechanism.

oscillatory movement is imparted by the motion of the armature of the electromagnet, E. The apparatus is of a simple make and break character, the interruption of the circuit taking place between *f* and *g*. A circular hole is cut in the disc, *a*, at *h*, and this is placed on a level with the flame of the lamp. The movement of the disc causes the light to be alternately covered and uncovered, the return motion being obtained by the aid of the greater weight of the lower portion of the disc.

As already intimated, the apparatus is as yet only in the experimental stage, and it is therefore too early to discuss its suitability or otherwise. At the same time it may be said that signals fitted with such an apparatus as at present constructed would require to have the "flashing" indicated in the cabin, in addition to the indicating of the existence of the light. Moreover, the "flashing" would require indicating for signals which under ordinary circumstances

FIG. 33.

are in plain sight, for the reason that the apparatus does not "flash" the back light, which is the only part the signalman can see.

POINTS INDICATORS.

It sometimes happens that "points" are placed in positions where they cannot be seen by the signalman. In such cases the apparatus shown by Fig. 33 is sometimes used.

INDICATING THE SECTION BETWEEN CABIN AND "ADVANCE" SIGNAL.

It frequently happens that whilst the arm of an "advance" signal is visible from the signal cabin, owing to its being

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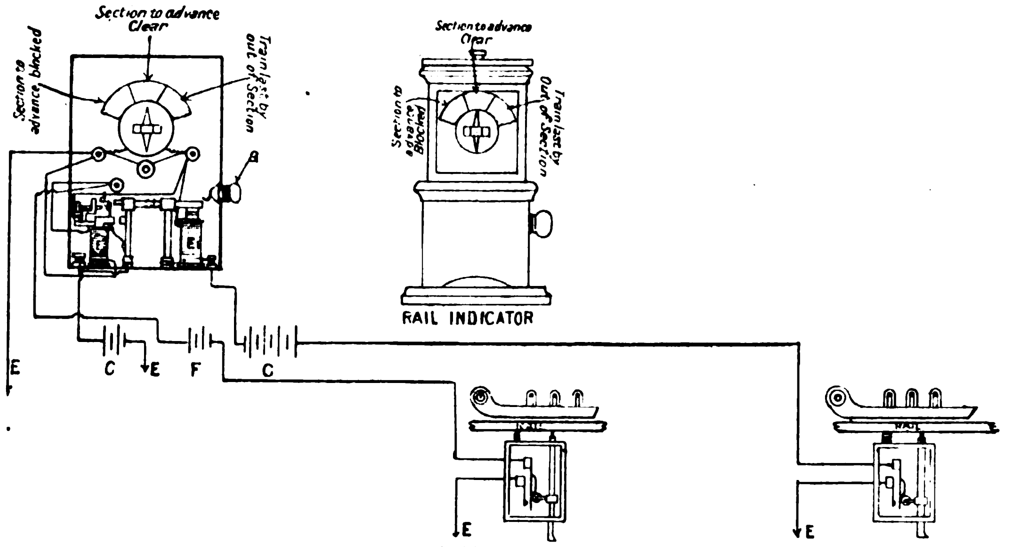
placed on a comparatively high post, the base, and a part of the line cannot be seen on account of some object, such as a bridge crossing the line, intervening. In such cases there is a possibility of a short train, standing at the "advance," being forgotten, and another train being sent into its rear. The apparatus shown by Fig. 34 is intended to minimise the danger arising in this way by indicating a section of the line, which commences somewhere near the cabin, and terminates at a point a little beyond the "advance" signal.

The apparatus consists of two rail contacts fixed at selected points, and an indicator. Line wires are run to each rail contact. When a train passes over the first rail contact the parallel bar is displaced by the flange of the wheel, and the magnet, E, is energised by current from the battery F. The armature of E is attracted, and the rocking bar, *b*, falls, locking the armature, and thus maintaining the local circuit through the battery C, *d*, and the indicator coils, and displaying the signal, "Section to 'advance' blocked." When the train passes over the second rail contact the electromagnet, E, is energised by the current from the battery G, the rocking bar is raised and the armature of E released, the local circuit of the battery C is broken and the needle of the indicator points to "Train passing out of section," which indication is maintained until the last vehicle, *in motion*, has passed over the rail contact. The normal position of the needle when no current is passing is "Section to 'advance' clear." The knob, *a*, at the side of the instrument is provided for the mechanical release of the rocking bar, *b*, from the position indicating "Section to 'advance' blocked" for cases where a train, having passed over the first rail contact, has shunted into a siding without having passed over the second. This last arrangement detracts somewhat the value of the apparatus as an automatic arrangement. It will be noticed that there are three batteries to provide two deflections only. The work of the local battery, C, might with a slight rearrangement of the connections be performed by the battery F.



Contact Blocking Section to Advance. Contact Clearing Section to Advance.

FIG. 34.

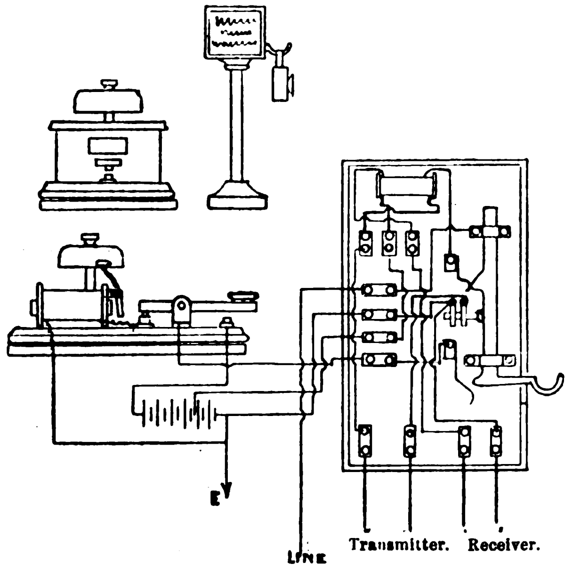


FIG. 35.—Block Bell and Telephone Circuit.

RAIL CONTACTS.

Rail contacts are not as yet so important a feature of railway signalling as they are probably destined to be when the apparatus used assumes a more automatic character than it possesses at present. One form of rail contact is shown by Fig. 34, in which the flanges of the wheels of a passing train are made to impart a horizontal movement to a bar laid parallel with and close to the rail, the return motion being obtained by a massive spring

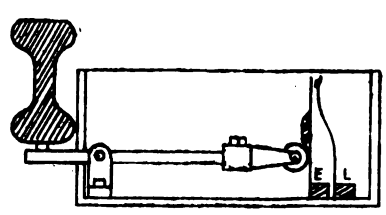


FIG. 36.

acting against the motion imparted by the train. Most rail contacts, however, are made to take advantage of the deflection of the rail by the weight of a passing train, in order to obtain the movement necessary for an intermittent connection. Several forms of rail contact suggested and used for various purposes are shown by Figs. 36, 37, 38, 39 and 40, and 41.

Rail contacts differ slightly in accordance with the character of the signal they are intended to provide for.

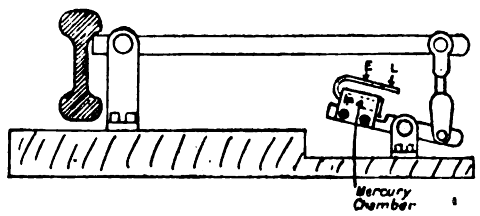


FIG. 37.—Circuit Broken.

Some forms only make contact during the time the rail is sufficiently depressed; others make contact for a longer period. Figs. 36 and 37 are examples of the first division. In the form shown by Fig. 37 the two connecting wires are sealed into one end of small chamber containing mercury, and the link work is arranged so that the mercury covers the ends exposed inside the chamber when the rail is pressed down. In this form a deflection of the rail of $\frac{1}{8}$in. is sufficient to make the necessary contact.

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Owing to the small deflection required, the outer lever is practically steady during the passage of a train.

Fig. 38 is an example of the form of rail contact, by which a more prolonged contact is obtained. The contact-making apparatus consists of two mercury-cups to which the wires are connected. When the rail is depressed, a metallic bridge-piece dips into the mercury-cups and completes the circuits. The lever arm carrying the metallic bridge is pivoted at or near its centre, and carries at the opposite end a semi-circular, perforated bowl, which under normal conditions dips into a vessel containing paraffin oil. When the rail is depressed the bowl is raised into the position shown, and is emptied of oil at the same time. When the train has passed over and left the plunger free the bowl slowly fills with oil and sinks, and by raising the metallic bridge out of the mercury-cups breaks the circuit. By proportioning the number and size of the perforations a contact for any desired length of time may be obtained.

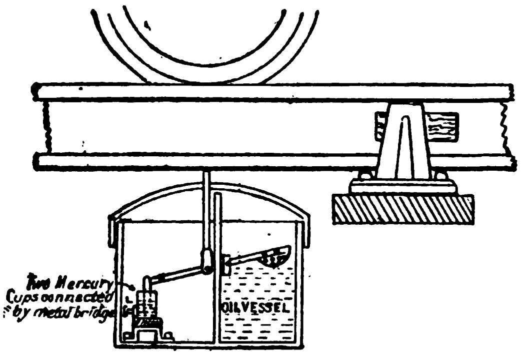

Fig. 38.—Circuit Closed.

Another form of mercury contact-maker, shown by Figs. 39 and 40, is that used by Messrs. Saxby and Farmer in connection with their system of interlocking the mechanical "advance" or "starting" signal with the block instrument. In this form the vertical motion of the rail is made to impart a horizontal motion to the mercury-cup, and the alteration of the level of the mercury brings it into contact with the curved metallic bridge seen in Fig. 40. The lever worked direct from the rail is locked with it, as will be seen from Fig. 39, and the return motion is also imparted by the rail.

Siemens's form of rail contact, shown by Fig. 41, is capable of giving a more or less prolonged contact by the depression of the rail. In this form mercury is also used to make the contact, and it is pumped, by the deflection of the rail, to a slightly higher level than the normal, in order

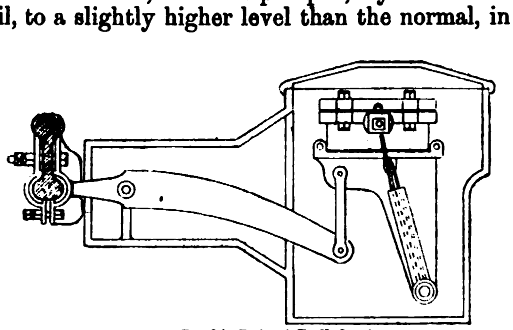

Fig. 39.—Buck's Patent Rail Contact.

to bring it into contact with the projected connection to which the line wire is connected. The spring-plate, *b*, is flexible, and on the deflection of the rail the mercury is forced up the tube, *h*, and into the small chamber, *c*. When the rail is released, the mercury runs through the hole, *s*, into the larger chamber and breaks the circuit. The difference in the levels of the mercury in the large chamber, and under the spring-plate, *b*, ensures the latter keeping the plunger, P, in contact with the under side of the rail, when the latter is not depressed. An indiarubber ring, *a*, is placed under the rail in order to exclude dust or grit which might impede the free working of the plunger. The apparatus is shown attached to a flat-bottomed rail, but it would equally be as easily fixed to one of the ordinary double-headed form.

Considering the forms of rail contact shown, and some of the duties they have, or may have in the future, to perform, it will be seen that they are, as has often been pointed out, defective, in that the first vehicle passing over the contact performs the duty which should be done by the last. "Last vehicle," in this case, implies something more than the last which passes a certain point, since it is quite possible for a train to divide and one portion to be left standing in such a position as constitutes it a danger to a succeeding train.

Consider, by way of example, the case for which the instrument and arrangement of rail contacts shown by Fig. 34 is intended, and assume that a short train is standing at an "advance" on a sharp curve, and out of sight of the signalman. So long as no part of the train has passed over the second contact, the indicator will remind the signalman of the presence of the train; but if only a part

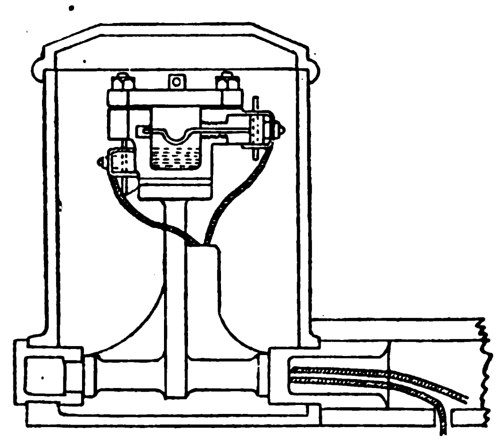

Fig. 40.—Buck's Patent Rail Contact.

of the train passes over the contact, the indicator will ultimately show "Section to advance clear." Under these circumstances the signalman would be justified in sending a succeeding train forward. It is true that the driver of the train is supposed to see that he has got the whole of his train with him, and it is also true that the guard on seeing a part of the train proceed forward should take steps to protect the part left standing; yet it is undeniable that most curious and, apparently, improbable combinations of circumstances are constantly arising. In any such event as that outlined, the indicator would be showing an incorrect signal.

It is, of course, a comparatively easy task to pick out defects in any form of apparatus intended for a specific purpose under varying conditions. These remarks, however, are only intended to show that the apparatus in

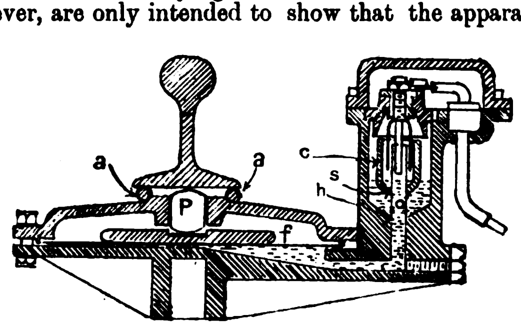

Fig. 41.—Siemens' Rail Contact.

use on railways for certain purposes is, in some cases, still in the evolutionary stage. Where rail contacts, of the forms shown in Figs. 36, 37, 38, 39 and 40, and 41, are intended to actuate apparatus which gives indications of the nature of "Line clear," they would appear to be ineffective in that they are unable to differentiate between the last vehicle of a train and any of the preceding vehicles.

In order to ensure the fullest possible protection to trains from apparatus, such as is shown in Fig. 34, or other apparatus indicating "Line clear," the last vehicle of every train should be capable of performing some duty that cannot be done by any other vehicle of that train. This, of course, involves the last vehicles being of a distinctive character to the others or provided with an attachment which shall be capable of performing for the indicating instruments the same function the tail lamp, or other "Last vehicle" signal, does for the signalman.

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TELEPHONES ON BLOCK CIRCUITS.

The extensive use of telephones on railways has led to the trial of combined circuits for telephones and block bells, the latter being selected because the currents used for bell signalling are transient only. A form of switch used for this purpose is shown by Fig. 35. The arrangement, of course, admits of being used between two successive cabins only. The block bell is used as a means of call to the telephone.

(To be continued.)

TRAMWAYS INSTITUTE OF GREAT BRITAIN AND IRELAND.

The annual meeting of this institute was held on Friday last at the Holborn Restaurant, W.C.

The retiring president, Mr. Carruthers Wain, took the chair, and the SECRETARY (Mr. Elliot) read the annual report as follows:

The council congratulate the members upon the considerable improvement manifested in its financial condition as evidenced by the revenue account and balance-sheet. The receipts have exceeded the expenditure, and practically the institute is free from debt. The continuous attention of the council during the past 12 months has been exercised in the same direction as heretofore—*i.e.*, in the opposition to attempts at legislation opposed to the ideas of shareholders in tramway companies; but this opposition has not prevailed, although in association with others, against the passing of a measure for working by the London County Council of the London Tramways nor against the suspension, now to become permanent, of the standing order under which heretofore local authorities were not permitted to work tramway lines if they could be leased. Other Bills have been successfully opposed, such as the London Valuation Bill of the County Council, Mr. Schwann's Bill for the working of the tramways by municipalities, of the Eight Hours Bill as relating to tramways, and the Locomotives (Persons in Charge) Bill. Moreover, encouragement has been given to a special form of tramway enterprise—*i.e.*, light railways—the beneficial legislation in respect of which must undoubtedly have an influence for good upon the tramway enterprise of the future, and this leads the council to hope that the present restriction on the rate of speed upon tramways, whether urban or suburban, may be removed, and thereby enable the companies to give that which they and the public equally desire, a better service to the inhabitants of any districts. The council regard with satisfaction the changes in the views of the various local authorities as evidenced by the fact that in Birmingham an extension of tenure has been given to a company formed to acquire the existing Central Tramways; that in North Staffordshire a new life has been given to that company by the whole of the municipalities in the district, and that at Southport a renewed term of 21 years has been acquired by the tramway company. Other corporations have followed on the same lines, and the council are glad to note the change in the opinion of the London County Council as evidenced by the debates of last year.

The retiring CHAIRMAN then proposed the adoption of the report and accounts. The latter he would not refer to in detail in the presence of the Press. Considering the small length of tramway line there was in the United Kingdom compared with the United States it was surprising what a hold tramway questions seemed to have taken on the public. Briefly referring to American practice, Mr. Wain remarked on the readiness with which in that country they would take up work not five years old and throw it aside as obsolete. Their boldness appeared to be justified by the financial results. Much had been heard of horseless carriages, but up to the present the main result of the horseless carriage had been to put money into the pockets of promoters. They would have the horseless carriage, no doubt, some day; but although he and others were doing their very best with the help of the electrical engineers to supersede horses, he fully expected that the harmless necessary horse would remain as an important factor in both tramway and other traction. As an instance of a growing change of spirit on the part of local authorities towards tram companies, he was glad to notice that the Birmingham Corporation had granted a new lease of the tramways for 21 years to a Canadian syndicate. As to conduit systems, it had been said that they were an absolute failure. He did not, from his American experience, believe that to be the case, and specially mentioned the Washington trams as working economically and successfully. He felt that a great deal of the prejudice against electrical traction had been really due to the manner of its construction. This especially referred to the overhead system. That was a cause that could be removed, and consequently a prejudice that could be dissipated. In moving the report, Mr. Wain said that his resolution not to accept re-election as president was an irrevocable one.

Mr. WHITTAKER seconded the resolution, and it was carried.

Mr. CARRUTHERS WAIN proposed and Mr. WHITTAKER seconded the election of Mr. J. Fell (Leamington) as chairman for the ensuing year, Mr. Whittaker remarking that there were several reasons why he could not be a candidate for that post himself, although his name had been put forward.

Mr. COOMER proposed that the election should be deferred and the council be empowered to communicate with gentlemen who were not members of the institute. There was no insignificant portion of the tramway interest of the kingdom that was not at present represented in their institution, and he wished to bring them in if possible.

The suggestion was ruled out of order, and Mr. Fell elected. The latter gentleman in his reply spoke mainly of matters already dealt with by Mr. Wain.

The following gentlemen were elected vice-presidents: Messrs. W. J. Carruthers Wain, William Turton, and W. Mason. The following were appointed the Executive Committee: Messrs. R. Whittaker, J.P., John Waugh, Wilborn Stansfield, and John Coomer. Messrs. Whiting and Millington were elected auditors, and votes of thanks were accorded to the late president (Mr. Wain), to the late auditor (Mr. C. James), and to Mr. J. G. B. Elliot, the secretary of the institute.

The meeting then proceeded to the reading of papers and their discussion. The subjects and authors of these were given in a note in our last week's issue.

Mr. WESTMORELAND'S starter-brake was taken first, out of its turn. This paper was commendably short, at any rate. The principle is that the car is stopped by throwing into gear a mechanism which causes the revolving axle to compress a spiral spring, the resistance bringing the car to rest. The energy of the spring is utilised to revolve the axle and start the car again. The inventor showed a model and rode upon it. Regarded in the light of a toboggan it was rather uncomfortably small, but grossly overweighted as it was by its inventor it stopped beautifully, and ran its own length again at starting. Something similar has been tried, it is believed, by a tramway company in France. In the discussion the obvious point was taken that there would not be so much power available in a stoppage going uphill as on a level, and that there would be too much going down hill. In reply to the latter objection, the inventor remarked that going down hill the emergency brake was employed and not the starter-brake. In the unlikely case of the failure of the emergency brake, of course the starter-brake would be available to stop the car, but care would be required in starting again.

Mr. T. H. BRIGG then expressed at very great length his views on the mechanics of horse haulage. These amount to the idea that the trace is generally attached to the wrong place. We believe the practice that has prevailed since the forgotten epoch when the first horse was tamed can be justified mechanically without any difficulty, but the subject does not concern electrical engineers. It may be noted that incidentally he claimed that the horse was the cheapest and most economical motor going, and considered that it reflected unspeakable shame on the century that talked so much of science and technical education that neither at South Kensington nor anywhere else had the economic method of horse haulage been investigated. The subject greatly took the fancy of the meeting and consumed the bulk of the time available for the papers and discussion. When this was finished, it being nearly 4 o'clock, it was decided to discuss the other papers unread.

Mr. J. RAWLINS was not present, and his paper—much longer than Mr. Westmoreland's—on another car

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starter passed without a word. Mr. Rawlins' starter-brake also works with a spring and is patented.

The next paper taken was Mr. FRANKLYN'S, on "The Brand Electric Railway System," of which the following is an abstract:

Electricity is acceded by all scientists to be the future motive power for travel. The following synopsis of the Brand electric railway system will fully demonstrate to the public in general its superiority over anything ever invented for the propulsion of street railways. Let us first take the present method employed in the overhead or trolley system. The trolley wherever employed is absolutely turning the streets of a city into one vast death-trap, inasmuch as it is distributing a death-dealing fluid broadcast over the streets, not only to man and beast but to everything beneath the earth in the shape of water, gas, and all metallic pipes—in fact, wherever conditions xist for the action of electrolysis.

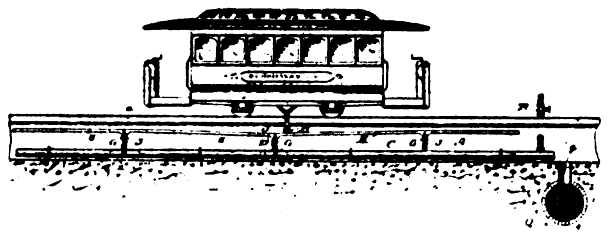

FIG. 1.

Now, the matter of absolutely overcoming and guarding against all the foregoing evils is positively accomplished in the Brand electric railway system, which, by referring to the working drawings, can be explained as follows : In introducing the Brand system we show the great advantages over all other inventions by its perfect immunity against atmospheric tunnel and earth influences, and which are known to be so detrimental to an electrical conductor carried underground.

In avoiding this great question of the loss of a current we clearly demonstrate the means employed. First, the perfect hermetically sealing, and thereby insulating the conductor. This, without any question, is the very fundamental principle of our system, and will necessarily follow in the perfecting of any system. Now to obtain this result, and at the same time to come in contact with the hermetically-sealed conductor, at all points and at all times, we employ the most simple and practical device known to the mechanical world—viz., the simple vertical movement of a piston or plunger working in conjunction with an hermetically sealing device, known as the simple flexible diaphragm. In the mechanical arrangements of all the parts strength and durability are the prominent features. The uncertainty of wire bondings and connections are avoided and used nowhere. First, in the trolley service conductor, rail is used from point to point of contact, whereby absolute certainty of electrical charging of the trolley service rail is accomplished at all points wherever a car may be stationed on the line.

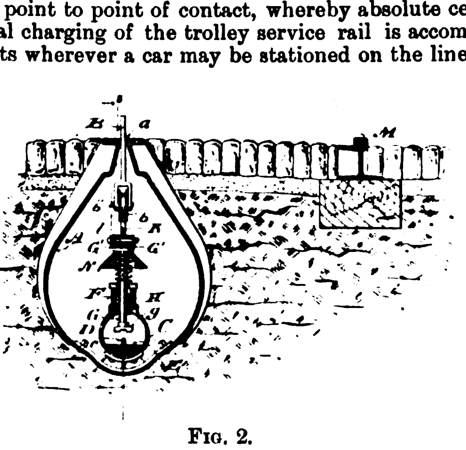

FIG. 2.

In the construction of the parts employed in this system great consideration has been given to compactness of the construction throughout, and avoids one of the great questions heretofore existing in other systems where the underground trolley system has been an experiment. We show that the parts in their entirety are accommodated in a 13½in. conduit or casing in height by 12in. in width. This brings the cost of this perfect underground system within reasonable figures, and nearly approaching, or even less than, a first-class construction of the overhead deadly trolley work. This will satisfy at once the demand of the public without cost to the operation of the traffic line in the large cities of the country, and further, as to the question of repairs, they are of such small consideration compared with that of the overhead system, that electrical and mechanical engineers unanimously endorse features herein employed as being of the highest efficiency.

In the construction of underground conduits for electric conductors for electric railway lines much difficulty has been heretofore experienced from the fact that by the ordinary forms of construction the wires are unprotected from dampness which accumulates in the conduits, and consequently short-circuiting or grounding of the current is liable to frequently occur. The object of our invention is to provide an underground conduit for electric railway conductors of such construction that the conductors will be effectually protected from dampness, said conductors being wholly enclosed with an airtight casing or covering, and provided with suitable means for making contact at intervals with said conductors, and for conveying current therefrom to the motor upon a car through the medium of movable service rails.

Referring to the accompanying drawings, Fig. 1 is a longitudinal sectional view of a conduit constructed in accordance

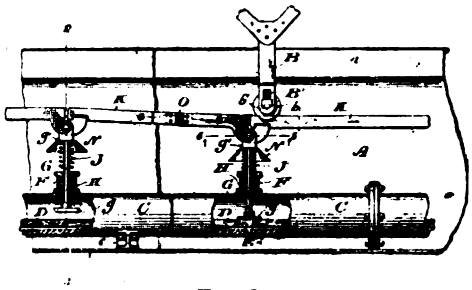

FIG. 3.

with our invention, and shows a car located upon a track and provided with a contact device in operative engagement with the service rail ; Fig. 2 is a transverse vertical sectional view of our improved conduit, taken on line 2—2 of Fig. 3 ; Fig. 3 is a longitudinal sectional view of the same taken on line 3—3 of Fig. 2 ; Fig. 4 is a detail vertical sectional view of a somewhat different form of device for normally holding the service rail out of contact with the conductors ; Fig. 5 is a horizontal sectional view illustrating the construction of the joint between adjacent sections of the service rail ; Fig. 6 is a detail plan view of a somewhat different form of construction of joint ; Fig. 7 is a side elevation of same ; Fig. 8 is a detail sectional view of a joint formed in the section of the service rail, said section being taken on line 8—8 of Fig. 3 ; Fig. 9 is a longitudinal detail sectional view, illustrating a somewhat form of conduit.

In the said drawings, A designates a suitable casing, preferably of metal, which is adapted to be located wholly beneath the surface of the ground, and is provided in its upper wall with a suitable slot, A, for the admission of a contact device, B. C designates a suitable tube or pipe, located in the lower part of the casing, A, and supported in position therein, in any suitable manner, as by means of the chairs, *c c*. A longitudinally extending conductor rail or wire, D, is located in the lower part of the tube or pipe, C, but insulated therefrom, said conductor being conveniently partly embedded in a suitable insulated material, E, which is located in the lower part of the pipe or tube, C. At suitable intervals along the upper side of the tube or pipe, C, we provide upwardly extending tubular connections, F F, through which vertically movable plungers, G G, are arranged to extend, said plungers carrying at their lower ends suitable contact shoes, *g g*, for electrical engagement with the upper or exposed portion of the conducting rail, D. As shown more particularly in Figs. 2 and 3, these plungers, G G, may be

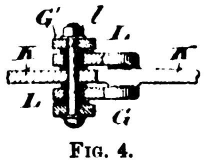

FIG. 4.

arranged to extend vertically through suitable glands or stuffing-boxes, H H, in the tubular extensions, F F, or, as shown in Fig. 4, said plungers may be arranged to extend downwardly through apertured elastic diaphragms, I, which are secured in any desired manner to the upper ends of the tubular extensions, F. Suitable springs, J J, are arranged around the upper portions of the plungers, G G, and are arranged to bear upwardly against suitable shoulders, $g^1 g^1$, thereon, said springs being arranged to rest at their lower ends upon suitable supports on the tubular connections, F F, so as to normally hold the plungers, G G, upward, with their contact shoes, *g g*, out of engagement with the conductor. To the upper ends of the plungers, G G, are suitably secured sections, K K, of the service rail, said sections being pivotally engaged with the upper ends of said plungers and with each other in the manner shown in the drawings. As shown more particularly in

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Figs. 2, 3, and 5, the adjacent ends of the sections of the service rail are kept out of contact with each other by means of insulating washers, L L, suitable bolts or rivets, 1, being passed through the ends of the said sections and said washers, and secured in any desired manner, so as to flexibly connect the ends of the sections together. We find it convenient to make the upper ends of the plungers, G G, bifurcated as shown more particularly in Figs. 2 and 5, the furcations, G^1 G^1, thereof being arranged to embrace the ends of the sections of the conducting service rail. As shown more particularly in Figs. 2 and 5, we establish an electrical connection between each of the plungers, G G, and one end of the movable section of the service rail through the medium of the pivot pin or bolt, 1, which, while it is insulated from one movable section, has metallic contact with the bifurcated upper end of the plunger, and the apertured end of one section of the service rail. It follows from this construction

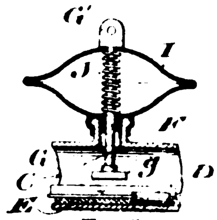

Fig. 5.

that by pressing downward upon any one section of the service rail, one of the plungers, G G, will be brought into electrical contact with the conductor, D, within the tube or pipe, C, at the bottom of the casing, and one section of the service rail will thereby be brought into electrical connection with said conductor.

In arranging the connections for the motor upon a car truck, said connections may be so made as to take current from the movable sections of the service rail through the motor, and to then pass the current to one of the track rails, M, in a familiar manner, or, if preferred, two tubular casings, C C, might be employed in the bottom of the main casing, and each arranged to contain a single conductor. It will be seen that as the car advances, the contact device, B, is brought into engagement successively with the several sections of the service rail, the said sections being depressed and brought into connection with

Fig. 6.

the conductor, L, as the contact device advances, and but one section, K, of the service rail being in circuit at one time. In order to enable the contact device to operate satisfactorily in depressing the several sections of the service rail, and at the same time ensure a perfect electrical contact with said section, we find it convenient to journal the roller, *b*, in movable boxes, b^1, which are pressed downwardly by a spring, B^1, so as to forcibly hold the roller, *b*, in engagement with the upper side of the service rail. As soon as the contact device has passed from one section of the service rail into engagement with the next adjacent section thereof, the springs supporting the plungers connected with the first-mentioned section will serve to automatically raise said plungers and said movable sections so as to break the electrical contact between the plungers and the conductor. If desired we may employ means such as shown in Figs. 6 and 7 for permitting the contact device to come

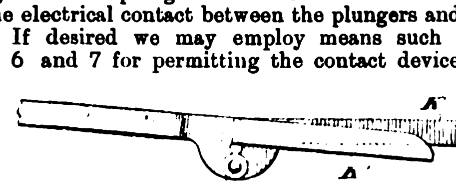

Fig. 7.

into engagement with the sections of the service rail before passing the joints between the adjacent ends of said sections, and to this end we find it convenient to arrange at one or both sides of the joint between said sections, suitable extensions, K^1, which are arranged to extend somewhat beyond the point of engagement between two sections, K K, of the rail, and into position for engagement by the contact roller a little before the joint is reached. In this manner, as the contact device approaches a joint in the service rail, and depresses the adjacent ends of the two sections connected by said joint, the rear end of the section with which the contact device engages will be free to rise about the time that the contact device reaches the joint, and as soon as the electrical connection of the rear of said section is broken, said section will, of course, be dead, while the next succeeding section will be in circuit, and it therefore follows that by the engagement of the contact device with the extension, K^1, of said next succeeding section, just before the point is reached, the contact device will be enabled to take current from said succeeding section, and a constant flow of current through the motor is thereby insured. This feature of our improvement is of especial importance upon grade, where an instant's break in the current might cause a stoppage of the car.

As shown more particularly in Fig. 2 of the drawings, we find it convenient to provide suitable means for protecting the movable parts from the accumulation of dirt which may find its way through the slot in the casing, A, and to this end we may provide suitable hoods, N, upon the upper ends of the plungers, G G, arranged to shed or deflect any dirt which may fall through the slot, and prevent the same finding its way into or upon the stuffing-boxes through which the plunger is passed, thereby guarding against undue wear on the stuffing or the moving parts. In the particular device shown in Fig. 4, however, no such precaution will be necessary, inasmuch as the upper part of the plunger is enclosed within the elastic diaphragm, 1, and all dirt is effectually excluded therefrom. If desired, I might employ between adjacent sections of the service rail suitable insulated joints such as shown in Fig. 3 and Fig. 8 at O, the connected ends of the sections being electrically

Fig. 8.

insulated from each other in a familiar manner. By this means the adjacent ends of the sections which are pivotally secured together might receive current from one plunger at the same time, the insulation in the joint between said sections being, of course, omitted. In the form of construction (shown in Fig. 9) I have illustrated the conductor, D, as enclosed in a suitable insulating cover, D^1, throughout the greater part of its length, but being bared at intervals, as at *d d*, and arranged to extend horizontally through suitable hollow casings, P P, within which the plungers, G G, are arranged to operate in the manner before described. In this form of construction, the entire housings, P P, as well as the insulated conductors, may be buried in a suitable cement or other material at the bottom of the casing, A, it being only necessary to arrange the housings

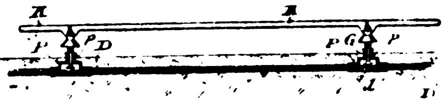

Fig. 9.

so as to permit the tubular extensions, *p p*, thereof to extend upward through said cement or other material so as to enable the plungers, G G, to engage therewith. By our improved construction, we are enabled to effectually protect the conductor against dampness and to thereby guard against accidental short-circuiting or grounding of the current and consequent derangement of the system. As a further and separate improvement we prefer to connect the main casing, A, at suitable intervals with a sewer, Q, by means of suitable tubular connections, *q*, so as to enable any accumulation of water within the casing to find its way out of the casing into the sewer.

As a still further and separate improvement we prefer to provide a suitable blast pipe, R, at any convenient point or points along the line of the conduit, and arranged to communicate with the interior of the tube or pipe, C, whereby a blast of hot or dry air may be forced through said pipe or tube to drive out any moisture that might find its way into the same on account of a leak in the pipe or tube.

Important questions and answers that are asked in connection with electrolytic action, and how it is absolutely overcome in the use of the "Brand" electric conduit tramway and railway system.

Q.—What is induction? A.—Dissipation of the current scattering broadcast in the earth.

Q.—What follows induction when the dissipation of the current is scattered in the earth? A.—Electrolysis.

Q.—What is the harmful action of electrolysis. A.—It destroys all metallic improvements such as gas and water pipes, paid for by the public tax.

Q.—How can this be prevented? A.—By the conductor carrying the current outward from the source of power, the dynamo, to any terminal or objective point, and returning the same through a thoroughly insulated cable back to the dynamo.

Q.—How can you do this? A.—Through an enclosing tube or pipe carried the entire length of the conductor, and the conductor hermetically sealed or enclosed therein, and the two together to locate within an open tunnel or conduit in the street.

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Q.—How do we obtain the power of this current from within the hermetically sealed tube or pipe? A.—For the particular purpose of propelling street cars or trams by drawing the current off at spaced intervals 20ft. or more, and by inserting through the walls of this tube or pipe a copper contact post or piston, offering a direct and unfailing electrical contact for the passage of the electrical fluid up to the trolley and thence to the motor.

Q.—How much depression is needed or movement required through the wall of the tube or pipe to make contact? A.—Just enough movement is necessary for the piston to make and break the contact—under 600 voltage used in power service, ⅝in.

Q.—How is this accomplished? A.—By the means of a trolley wheel rolling upon the service rail as the car advances.

Q.—What breaks the contact? A.—The upward tendency of the spring in the diaphragm after the pressure produced by the trolley is relieved.

Q.—How do we seal the opening through the wall in the tube or pipe in which the plunger works or moves against the entrances of water, gases, dirt, etc.? A.—By the metallic flexible diaphragm (see drawing).

Q.—Is this durable? A.—Not being subject to any rubbing or wearing friction, in having only to depress the space of ⅝in. to allow the plunger to make the contact, the wear would be imperceptible year following year.

Q.—What will the flexible diaphragm be composed of? A.—What is known as spring-bronze metal, or galvanised spring metal of various kinds.

Q.—Will arcing take place under the foot of the piston at the instant contact is broken? A.—No; for the reason that as soon as the trolley passes midway between the plungers, contact is instantly made with the next plunger, and an arc will not span the space when one of these plungers is down.

Q.—Why? A.—Electricity will make no effort to reach over the space intervening between two points of metal when an absolute metal path of copper is made for it to follow, therefore an arc cannot form when the piston breaks contact with the conductor.

Q.—Why is it absolutely necessary that the electrical conductor should be hermetically sealed? A.—The earth is at all times a great induction magnet, constantly tending to rob a naked conductor of the electric fluid.

Q.—Will the tube used in this system prevent the wholesale robbery of the current? A.—Yes. Nothing could be more absolutely sure than the means here employed in the prevention of the current escaping into the earth, for the reason that all electric companies, telephone, fire alarm, telegraph, etc., are enclosing naked wires within tubes or pipes. This is a simple matter, providing they need not be tapped for the purpose of extracting the current, but in the case of street-car power, the current must be drawn at all times, and therefore drawn off at intervening points as shown.

Q.—Will the tube prevent dampness from interfering with the current? A.—Yes; by the simple means of an asphalte coating applied throughout its inner surface, or by means of an air-blast pipe (see Fig. 15 in plans) operated at the power-house, and a blast from a Sturtevant blower if necessary.

Q.—How will the current return to the dynamo so as to prevent escape and electrolytic action? A.—After being carefully provided against escape in its outward course it is returned through a perfectly insulated cable, located parallel with the conductor, and which can be located anywhere within the outer tunnel or conduit. This will ensure what is known as a metallic circuit from the dynamo out and back.

Q.—How will the current meet this return cable after performing its work through the motor? A.—When the current has passed through the motor it immediately seeks the earth through the axle and wheels of the car-truck, and to the track and rail, thence to the next rail, and so on through series of rails to the dynamo, barring what does not escape into the ground at each defective joint, at each and every rail. If these rails were jointless, or one continuous rail, they would offer a perfect conductor in themselves.

Q.—Why is a separate return cable better? A.—Because it is without joints, offers no place for escape on the current's return home, and in this return cable the current is caught up, and gathered from each rail by short cables branching on to this main cable, and allowing no current to escape into the ground, and the whole waste which is causing electrolysis is conveyed. After these vital questions have been put and answered, and everything showing the means of getting at the power of hermetically-sealed electricity, and using the same force, and returning it back to the point of beginning or its source, no objections should stand long in the light of an intelligent argument in favour of the "Brand system," where not only the electrical difficulties are absolutely overcome, but the mechanical difficulties also, and so palpably plainly, that little is left for the mind to grasp in its comprehension.

Prof. LUPTON opened the discussion. He was simply appalled at the delicate apparatus that the author proposed to put under the streets. An electrician of great skill might be able to make such apparatus, but where were the army of skilled men to come from to get into the tube and keep it in repair through all kinds of weather? Contact-makers had been devised before, and had had their day, and it would be interesting to hear why Mr. Brand's ingenious system was expected to have a longer life.

Like Thackeray's "Little Billee," Mr. STURGEON had been endeavouring to recite his "catechee," and he found it a stiff piece of work. It began, "What is induction?" and the answer was, "Dissipation of current scattering broadcast through the earth." After that he did not intend to follow the author of the paper through his ideas of electricity. The ⅝in. allowed between the collector and the point of contact might be sufficient at first if the line was laid very carefully indeed, but it would not be maintained when the rails and wheels began to wear, and the trolley would soon be jammed down on the electrical contact. The system appeared to have many of the disabilities of the overhead trolley system with several additional of its own.

Mr. SELLON could not help looking upon the paper as an attempt to put before a body of gentlemen who knew something of the subject a system the details of which were of the most amateur description. The statement that the trolley was turning the streets and cities into a death trap was simply an absolute absurdity. Mr. Sellon also referred to the "catechism" at the end of the paper. It reminded him of nothing so much as a book called "Brewer's Guide to Science," which had considerable vogue in the days of his childhood. They had discovered a little since those days, and if Mr. Brand's system of traction was on the same basis as the answers to questions at the end of the paper, he could only advise him to learn a little electricity. One thing only he would say—namely, that Mr. Brand's return was practically just the same as the ordinary return through the rails, and all that was said as to electrolysis was consequently wide of the mark.

There was no reply on behalf of the author. It is, however, right to say that in the way the papers were taken it was not very easy to tell when any one of them was likely to come on, and the author's absence may have been accidental.

The next paper was one by Mr. J. STURGEON on "Mechanical Haulage on Tramways." It was practically an advocacy of the cable system which mainly took the form of an attack on electric traction. The history of electrical traction for tramways had been one continuous record of financial failure. The accumulator system was introduced into Brussels with the usual flourish of trumpets, and had failed completely. Great hopes were entertained of the electric system in Birmingham. The expenses on that section had kept increasing, until last year they amounted to 18·43d. per car mile. These were accumulator systems, but electricians were just as cock-sure about those systems five years ago as they are about overhead and conduit electric systems to-day. The principle was still just the same—traction by adhesion of the wheels—only varied slightly in detail. In last year's report of the directors of the Chicago City Tramways the old familiar paragraph cropped up again in the expression of the surprise and disappointment of the directors to find that the working costs of the electric system (overhead) were 70 per cent. more than the cable, notwithstanding that the electric cars had the advantage of running at nearly double the speed, and they had no Board of Trade to interfere with them on behalf of the public safety. The Roundhay electric line had proved a complete financial breakdown. If ever an electric system had a fair chance of paying that had. The South Staffordshire Electric Tramway was worked by contract, and no outsider could tell what it really cost. It would be interesting to watch how recent electric concerns came out under the operation of the new Board of Trade rules, issued in March, 1894. These rules were very stringent, and if electric traction could hardly manage to keep up a brazen front when free from their operation, how long might they expect the recent installations to exist under them? As to electrical leakage and its destructive effects upon gas and water mains, etc., he would strongly advise all those who were

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interested in the subject to read the evidence of Major Cardew, Dr. John Hopkinson, Mr. Preece, and Sir F. Bramwell before the Parliamentary Committee on the subject. In fact, overhead electric traction had already seen its best days, and was doomed to follow in the wake of the accumulator, so now there were signs and tokens of another new departure in the form of conduit systems of electric traction. A new era of experimenting in these systems had been entered upon. But there was nothing in the nature of underground or conduit systems that could in any way help to lessen the cost. It was a hopeless task that electric tractionists had taken upon themselves, and the new departure was bound to depart, too, on the same road as the others. Propulsion by the adhesion of the wheels was wrong in principle, and under the conditions of street traffic no method of traction by adhesion could possibly, from the very nature of things, compete with methods of traction by pulling with simple rolling action in the wheels of the vehicle. In a cable system they had to provide for the driving of the cable, and then could string on to it as many light cars as they liked, adding power only to overcome rolling friction. The cable itself was always in equilibrium and always in continuous motion in one direction, so that it might be regarded as a sort of flexible flywheel, with its weight distributed over many bearings instead of concentrated on one. The author then very briefly described a new form of "gripper," by which it was possible to diminish the depth of the conduit and the interference with the streets in laying it.

Prof. LUPTON, from experience in mining work, maintained the excellence of the endless cable system. Miners were often carried miles underground to their work, so his experience really covered the case of passenger traffic. It was an advantage of the cable system that there was "no electricity grinding, and the power went direct to the work to be done." Also putting on additional cars made little additional work.

Mr. SCOTT RUSSELL considered there was room for both electric and cable systems. Owing to the power required to run the cable the latter was out of the question when there was not a frequent service.

Mr. SELLON, in reference to the comparison of the cable to a flywheel, said that he had yet to learn that it took 40 to 50 per cent. of the power of an engine to drive its flywheel. If so, it was another entirely new point in mechanics. As to the Roundhay line, it was only put up as an advertisement. It began at one place and ended nowhere; but its working figures were, as a matter of fact, very successful. In order to discredit overhead electric traction, Mr. Sturgeon had brought forward cases where accumulator traction had been a failure. What had that to do with it? The eminent electrical authorities whose names had been referred to in connection with the committee happened to be all engaged on behalf of telephone or gas and water interests. The conclusion arrived at was that under the Board of Trade regulations as now in force there would be no electrolytic action. Electric tramways, as a matter of fact, could and did conform to those regulations. The amount of electrical leakage was not a matter of speculation, for what there was had to be measured and the recorded amount forwarded to the Board of Trade every week. He was quite prepared to admit the advantages of the cable system when there was a very large amount of traffic. Finally, if the cable system was so good there was no necessity for Mr. Sturgeon to have devoted so much space to condemning electricity. He (Mr. Sellon) would have preferred to have had some figures and particulars showing that the cable system produced better results.

The AUTHOR (Mr. Sturgeon) replied. He had intended to consider only tramway traction in towns, which implied a frequent service. Electric traction might do for a suburban line with a service of four cars an hour. Additional cars could be easily put in a cable system, but on the electric system the "resistance goes up in proportion to the square of the current." (This was how it was put, but the meaning is obvious.) The American electric lines depended for success on high speed, high voltage, and high fares, and were allowed to kill people in a way that would not be permitted here.

Papers on tramcar check-tickets, harness, horseshoes, and bells and seats completed the list.

The annual dinner of the institute took place the same evening at the Holborn Restaurant, the new president occupying the chair. The invitation was to meet the Right Hon. C. T. Ritchie, M.P., President of the Local Government Board, but that gentleman was prevented being present by the pressure of parliamentary business. A similar cause probably kept away Mr. Pritchard Morgan, M.P., but Mr. Atherley Jones, M.P., was there, as were also Sir John Puleston, Mr. H. C. Godfrey, Mr. W. J. Carruthers Wain, Mr. W. Mason, Mr. N. Scott Russell, Mr. E. Garcke, Mr. R. A. Germaine, Mr. J. W. Clydesdale, Mr. Bassett Hopkins, Mr. T. H. Bolton, and Dr. Ginsburg.

Mr. T. H. BOLTON proposed the toast of "The Houses of Parliament," and this was replied to by Mr. ATHERLEY JONES, who referred to legislation in progress with a view to the development of light railways, tramways, and motor-carts, which showed that the institution had a wide field of work before it.

Mr. GODFREY having proposed "The Local Authorities," Mr. BASSETT HOPKINS replied.

Sir JOHN PULESTON proposed "The Tramways Institute," remarking that at one time it was very difficult to exploit a tramway in this country; but now it had come to pass that no one would wish to be without trams. The Tramways Institute had done much to bring this about. In view of the interest of the public, he regretted the legislative restrictions that were imposed upon tramway traffic. He was of opinion that one of the restrictions which was most irksome was that which prohibited tramcars being propelled at more than eight miles an hour, which was, he thought, a speed that might approximately be doubled without inconvenience or danger to the public. The progress made by tramways in this country had been very great, and at no time had that progress been more manifest than it was now. So that when they next met he hoped they would be able to congratulate themselves on the success of a new mode of traction which would still further improve the tramway service.

Mr. CARRUTHERS WAIN replied, and referred to the work of the institute in watching and preventing legislation injurious to tramway interests.

Mr. HAMMERSLEY (Hanley) proposed "Traction: The Survival of the Fittest." He hoped the survival of the fittest meant the system of overhead electric traction adopted in his district with the help of Mr. Garcke and Mr. Sellon, and he was quite certain it meant the survival of the Tramways Institute.

Mr. HAMMOND replied to this toast. As to what would survive in the future, so far as tramway traction was concerned, he was certain it would not be the horse. As an electrical engineer, he considered the field of traction one of immense interest, and he would willingly exchange two or three lighting retainers for one traction retainer. He had been connected with electric lighting from the very first and the problems of distribution which it involved, but he thought that in the future the greatest problem of the distribution of electrical power would be its distribution to the moving tramcar. The horse required a good deal to keep, and involved using as much force to pull a light car as a full one. The greatest force at their disposal was that contained in the coal measures, and the best way of utilising it was the central station and electrical distribution. Therefore he thought the traction of the future would be electric traction.

Mr. MASON proposed "Kindred Institutions," for which Mr. N. SCOTT RUSSELL, M.I.C.E., replied, and other toasts were "The Visitors," "The Press," and "The President."

A programme of music was arranged under the direction of the secretary, Mr. Elliot.

Accident.—It is stated that last week, on the Budapest underground electric railway, one of the carriages, in which were six passengers and two railway employés in charge, suddenly took fire as it was travelling rapidly. The terminus was reached, but the car was totally destroyed at the end of the journey. The passengers were naturally frightened, and the men in charge sustained some injury.

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WORK v. FINANCE.

In a recent issue we gave the views of our Consul at Bilbao, that English firms were allowing business to pass by and to fall into the hands of competitors. No doubt there is a large amount of truth in this; but, without at the present moment enquiring specially into the case of the Bilbao district, it may not be amiss to discuss the question as it presents itself to many of our manufacturers. The first aim of a business man is to obtain business, and under ordinary circumstances he will leave no stone unturned to get any work that may be going. Electrical engineering, however, does not run upon commonplace lines. It is not so much a question of work going a-begging as of making work. We may illustrate the method of procedure by a specific example, one, indeed, of many, any one of which would prove our case. Assume you have a pushing young man wanting to make a little money or earn a position in a town not too well favoured with artificial light. He thinks "electric light" will go, makes a few enquiries, gets a few promises of support, and then goes about to financiers or manufacturers with a crude scheme suggesting that they should take it up for a consideration. If a manufacturer on going into the matter imagines that it may prove successful and decides to assist the applicant, he has in the first place to arrange the financial question, for upon this depends the work. It is not the case of someone coming to him with money in their hands seeking quotations, as it is the finance of probably successful schemes in order to obtain work for his factories. We need not point out the result of these financial transactions—that is well known, the effect being often doubtful paper profits, locked-up capital, hence larger capital required than would be wanted if manufacturing was the only business of the firm. If a financier takes up the matter he frequently takes it up in conjunction with the manufacturer, and he has to take his risks and his profits. Altogether, then, many of the schemes are fearfully overloaded at the start, and it is a wonderful proof of the value of electric energy that many more schemes have not been absolute failures.

The development of foreign business, then, depends almost entirely upon the financial position, and in many cases work has gone to our competitors, not because it was not offered or could not be obtained by us, but because our financiers and manufacturers declined to run the risk. Some months ago, for example, a man with a scheme was over in London from Iceland; no doubt this particular scheme has been considered by a number of firms in this country, but as yet no sign has been made that any one has accepted the offer. We should not be at all surprised to hear that the work is to be carried out by a foreign firm. This would merely show that English firms thought the risk too great, while their competitors accepted the risk. Of course, many such schemes are being constantly considered, and doubtless some which we consider bad have the elements of success in them, go to competitors, and help to swell the tide of their successes. On the whole, however, we think it better not to venture on these

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risky speculations than to venture on the off-chance of its turning up trumps. We have thus briefly described the ordinary course of procedure. Where the Englishmen seem to fail in pioneer work is in waiting till promoters come to the financier or manufacturer, instead of the financier or manufacturer touting for themselves. It will be seen we assume financial aid to be all-important. When this is at the back of the manufacturer, the latter can afford to pick out the likely places for success by means of his own agents. Taking the case of Spain, one district of which we have previously referred to, some English firms, at any rate, are active in this market. Madrid has been more or less exploited, and according to our latest information there is to be a central station at Malaga which Messrs. Fowler and Co., of Leeds, will equip with the necessary plant, and the British Insulated Wire Company have the order to supply their H.T. lead-covered type of cable, which is to be laid in Doulton's conduits. Mr. Hammond is the consulting engineer, and Mr. Slater, lately at the Blackpool station, is engineer-in-charge. At the same time it may be mentioned that Messrs. Fowler and Co. are carrying out extensive works at Madrid. We mention these cases to show that work is being done in Spain, but whether this work comes within the category of that requiring financial aid or not we have no knowledge. It is quite certain, however, that, given financial aid, work will not be difficult to find, and it seems to us that the formation of such companies as the Electrical Development, just announced, is a move in the right direction, if great care is taken to finance only those schemes which have been carefully considered and present the minimum of risk.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

ARC LAMPS.

SIR,—A contemporary having made a statement to the effect that Brockie-Pell Arc Lamp, Limited, has been formed for the purpose of taking over part of our business, we shall be glad if, by the courtesy of the editor of the *Electrical Engineer*, we are allowed to inform our customers and friends that the company referred to leaves our business alone, taking over from us only Messrs. Brockie and Pell, in whom we cannot claim to have proprietary rights. The company, we understand, has been formed for the exploitation of certain of Mr. Brockie's patents for which we did not see our way to make an offer, but our name did not appear in the prospectus. We have no interest in the concern, nor do we consider that our business in arc lamps will be adversely affected by it. We shall continue to manufacture our lamps as before, bestowing upon them that care in make and finish to which their great success in the past has been due. It may be difficult for experts to detect the difference between our lamp and that known up to the present as the "Brockie-Pell," but to our customers the difference will be apparent, inasmuch as the price of ours will now be reduced by the amount hitherto paid in royalties.—Yours, etc., JOHNSON AND PHILLIPS.

Egyptian Electric Tramway.—The electric tramway in Cairo, the first constructed in Egypt, has just been successfully inaugurated by a trial trip in the presence of Fahkry Pasha, Minister of Public Works, and a large number of spectators.

THE MISTAKES THAT MAY BE MADE IN CONSEQUENCE OF THE PREVAILING TENDENCY TO REDUCE THE SPEED OF ELECTRICAL MACHINERY.*

BY WILLIAM BAXTER, JUN.

Within the last two or three years the tendency to reduce the speed of electrical machinery has been growing so fast that it is desirable that the subject should be considered from various standpoints and the idea determined whether there is not such a thing as going too far in this direction. It is very important to know how long high-speed machinery will last, or at least what is its relative life compared with the slow-speed types. If the life of the former is but a few years, the slow-speed is undoubtedly better; on the other hand, if the high-speed type will last for many years, the case is quite different. Past experience seems to show that high speed in electrical machinery is not very destructive. There are very many high-speed dynamos in use to-day which have been in constant service for over 15 years, and are apparently in good condition. Many of these machines have solid bearings, but notwithstanding this the original bushings are in many cases still in use. The commutators have worn out and some have been replaced several times, but since the introduction of carbon brushes, wear, in this respect, has been reduced to a minimum, and unless there is considerable sparking, the commutator should now last almost indefinitely. The speed of what are considered high-speed engines is very low when compared with that of dynamos connected directly to steam turbines, yet the wear on these machines does not appear to be serious. Owing to the fact that electrical machines have but one moving part, and that the motion of this is rotary, high speeds are not likely to produce serious results unless the moving part is not properly balanced, a condition, however, seldom or never met with in machines turned out by any first-class manufacturers. A speed of 700 revolutions per minute would not bring any undue strain on a 100-kilowatt generator designed for a speed of 250 if direct connected. With this latter type of generator slow speed is desirable, in fact, necessary, on account of the limited speed of the engine. Engines of the size used for this purpose run at piston speeds ranging from 500ft. to 600ft. per minute, and the driving pulley is generally of a diameter about five times as great as the stroke. The belt velocity under such conditions is $5 \pi S \div 2$, S being the piston speed in feet per minute. Assuming a 100-kilowatt generator to be driven by such an engine running at a piston velocity of 600ft., the belt speed would be 4,710ft. per minute. This velocity would reduce the belt strain to about 1,000lb., which could be transmitted with a 14in. double belt. The speed of the generator would be about 500 revolutions per minute with a 3ft. pulley, and 600 by reducing the pulley to 30in. This would be a decided improvement on the results obtained with a speed, say, of 350 revolutions per minute, as the width of the belt would be reduced from 20 required for such a velocity to 14in., and the cost of the generator would be considerably less. There can be no question but what direct connection is the best for large units, say, from 200 kilowatts up, for with machines of that size the belts required to transmit the energy are so large as to be troublesome as well as costly, but it is not by any means certain that any advantage can be shown by direct-connected units of half this capacity. Many are willing to pay for compactness and simplicity, and such will use direct-connected generators, whether they possess any other advantages or not. But many others look wholly to the economical side of the case, and use that type of machine which will give the best results for the money invested. A direct-connected generator economises space, saves the expense of belt renewals, offers less danger, and is perhaps a more durable machine; but, after all, compactness is the only real advantage so far as small and medium-sized machines are concerned. The operation of belt generators shows that in the matter of durability they are all that can be desired. The wear and tear is not great, and it is very doubtful whether it will exceed 2 per cent. a year, including the

* From the *Electrical World* (New York).

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renewal of belts, excluding the uncertain item of armature burn-outs, which is just as likely to occur with direct-connected as belt generators. If the ordinary repairs of belt machines can be made for an amount not to exceed 2 per cent., it seems evident that the direct-connected generator will not be able to show much gain in the cost of maintenance. In certain lines of work where the changes in load are frequent and very violent, the wear and tear on a direct-connected machine is much greater than on a belted one. This is especially the case in railway work, where it is not an uncommon thing for generators to become short-circuited. In the former, the elasticity of the belt relieves to a certain extent the sudden jar, but with the latter, as there is a rigid connection between the armature and the engine, the strain is transmitted instantly and sometimes with serious results. In the matter of efficiency the smaller sizes of direct-connected generators are not equal to the belted machines as the speed is so much reduced the efficiency must be sacrificed in order to keep the cost of production within reasonable limits. In many cases the space is limited and a direct-connected machine is the only kind that can be used. The speed of belted machines when driven from a belt shaft may be made anything desired. In such cases a speed should be adopted which will give belt velocities ranging from 4,000ft. per minute for machines of 20 or 25 kilowatts to about 6,000ft. per minute for units of 75 or 100 kilowatts. With these velocities the width and cost of belts can be kept within reasonable limits, and the wear will not be excessive, as will be demonstrated by actual experience. Generators belted directly to the driving engine must conform to the velocity of the latter, and the size of the driving wheel, and therefore will not be able to run in most cases as fast as if driven from a line shaft. The desire to reduce the speed has not been confined to generators, but has also affected motors, and it may be said with very beneficial results, as in most cases these machines were formerly run at velocities much higher than were advantageous. As motors are used to impart motion to other machinery, their speed should conform to the requirements of the latter. Motors of small sizes—say, from 1 h.p. to 4 h.p or 5 h.p.—generally operate high or moderately high speed machinery, and the shafting usually is run at velocities ranging from to 250 to 350 revolutions per minute. As it is desirable to avoid the use of an intermediate shaft whenever possible, the speed of the motor should be low enough to belt direct to the line shaft. This can be accomplished in almost every case by adopting speeds ranging, say, from 1,400 for 1 h.p. to 1,200 for 5 h.p. A 4in. pulley on the 1-h.p. motor belted to a 16in. pulley on the line shaft would be in good proportion, and would give the latter a velocity of 350 revolutions per minute. As the belt speed would be nearly 1,500ft. per minute, a 1in. belt would be more than ample to transmit the energy, and a 2in., which is the size that would probably be used, would run with an exceedingly light strain. The speed of the shafting does not as a rule drop below 200 revolutions per minute in the operation of the general run of machinery, even when the power used is as high as 100 or more horse-power; therefore it is not necessary to reduce the speed of motors above 5 h.p. much below 1,000 revolutions. For example, a 10-h.p. motor running at 1,000 revolution per minute by a reduction of 5 to 1 would be belted direct to a line shaft running at 200. This reduction would be obtained by using an 8in. pulley on the motor and a 40in. pulley on the shaft. The belt speed would be 2,000ft. per minute, therefore a 4in. or 5in. belt would transmit the power. A 30-h.p. motor, running at a velocity of 900, would have to reduce in the ratio of 4½ to 1, giving the line shaft a speed of 200. This would be obtained by using a 14in. pulley on the motor and 63in. on the shaft. The belt speed would be about 3,300ft. per minute, which would call for a 7in. or 8in. belt. The highest speed that can be used with motors if they are designed to belt direct to the line shaft without losing too large a pulley on the latter would be found to be very moderate and much under that at which they could be run without injurious results. Nevertheless it is much better to adopt this low speed. A higher velocity would reduce the cost of the motor, and as a result the cost of the repairs thereon. But this gain could only be effected by using an intermediate shaft, and the cost of this would undoubtedly be greater than the saving in the price of the motor; furthermore, there would be two belts to wear out instead of one. It is evident, therefore, that nothing could be saved by running the motor at a higher speed, and much would be lost in the way of simplicity and compactness. It may be said, however, that while it is desirable to use just as high a speed as the conditions will permit of, so as to reduce the first cost as well as the maintenance it is not wise to use a speed so great that the motor cannot be belted directly to the line shaft, unless the case is one where the speed of shafting is so low as to render direct belting impracticable. Most of the prominent motor manufacturers are now making machines for three different speeds—that is, high, moderate, and slow; consequently, a speed to meet the requirements of almost any case can be easily obtained, if the purchaser in making a selection is guided by good judgment.

A NEW ELECTROLYTIC GENERATOR FOR OXYGEN AND HYDROGEN.

BY W. S. FRANKLIN.

During the year 1895 a preliminary test* of a generator, of novel design, for the rapid and efficient generation of oxygen and hydrogen by electrolysis has been carried out in the physical laboratory of Iowa Agricultural College. The earlier part of this test brought out, as was to be expected, a number of essential imperfections in the preliminary design, which was accordingly modified and the apparatus twice reconstructed. The experimental work was unexpectedly cut short in October, 1895, before the finally constructed generator was fully tested. The final design and the more important results of the preliminary tests are here given. The work is to be continued during 1896.

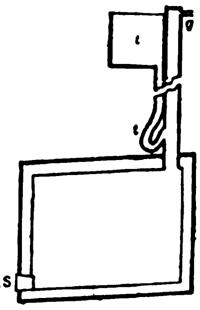

Fig. 1.

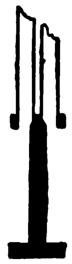

Fig. 2.

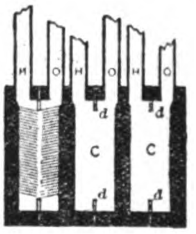

Fig. 3.

The generator consists of a number of massive frames cast of an alloy of 25 parts lead and 1 part antimony. The side view of one of these frames is shown in Fig. 1, and a sectional view in Fig. 2. These frames are bolted together, as shown in Fig. 3, the frames being separated by insulated diaphragms, *d d*, of gum rubber sheet of the kind used for steam packing. The central portions of these diaphragms are cut out as shown in Fig. 4. Two tall lead pipes and one reservoir and trap, *t t*, are fixed to each frame, as shown in Figs. 1 and 2. The watertight compartments, *c c* (Fig. 3), filled with dilute sulphuric acid (sp. gr., 1·17), are broken up by a number of thin glass strips, supported at the ends in hard rubber posts (Fig. 5). These glass strips, shown only in one compartment in Fig. 3, prevent the mixing of the two gases. The electric current enters the apparatus at one end frame and leaves it at the other. The gases collect in the tall lead pipes, pass out through glass tubes attached at *g* (Fig. 1), and are conducted to lead pipes leading to the gasholders. An opening, S (Fig. 1), two in each frame, closed with a rubber stopper, permits of the easy emptying and rinsing of the compartments. The generator is so supported that a vessel may be placed under these openings. The generator in the physical laboratory at Ames, now partly finished, is arranged in batteries of five cells each. Each

* By Messrs. C. R. Cave and D. M. Hosford. Thesis for 1895. MS. in the College Library, Ames, Iowa.

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battery weighs about 300lb. The lead frames are 25·5 × 20·4 × 8cm outside dimensions, the metal is 1·8cm. thick, and the other dimensions are shown in the figures. The openings in the rubber diaphragms are 13cm. by 19cm. Such a battery of five cells will stand a continued current of considerably more than 22·5 amperes, without overheating, requiring about 3·8 volts of E.M.F. per cell. The gases produced are not perceptibly mixed.*

In the preliminary tests a battery of five cells of the above dimensions was used. The holes in the diaphragms were only 7·5cm. by 15·2cm., and no glass strips were used to prevent mixing of gases.

With this battery, the E.M.F. per cell, the final temperature rise above room temperature, and the purity of the gases were determined for currents ranging from 5·9 amperes to 22·5 amperes. The results are exhibited in the following table:

Number of run.	Current (amperes).	E.M.F. per cell (volts).	Temp. rise (centigrade)	Purity of H (per cent.)	Purity of O (per cent.)
1	5 9	3·0	2°·5	91 6	75 0
2	7·6	3·0	2° 0	92 7	78·2
3	8·8	3 2	6°·5	93·9	83·0
4	11·2	3·4	13°·5	94·4	83 2
5	13·6	3·5	15°·5	94·8	85·0
6	17·3	3·6	16°·5	94·8	85·0
7	20·0	3·7	21°·8	94·8	85·5
8	22 5	3·8	24°·0	94 7	86·2

The diaphragms for the first battery of five cells which was set up were made of best quality hard rubber sheet 1·5mm. thick. After about a month these diaphragms were found to be very badly broken. The battery was then reconstructed, using gum rubber sheet 1·5mm. thick, as mentioned above.

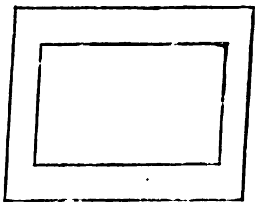

Fig. 4.

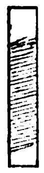

Fig. 5.

The efficiency of a hydrogen and oxygen generator requiring E volts per cell is calculated as follows: During the passage of one coulomb of electricity E Q joules of energy are expended, and ·00001039 Q grammes of hydrogen, and a corresponding quantity of oxygen are generated. The recombination of this H and O would give 34,200 × 4 2 × ·00001039 × Q joules, 34,200 gramme-calories of heat being generated by the combustion of one gramme of hydrogen in oxygen, and one gramme-calorie being equal to 4·2 joules. The efficiency is therefore $\eta = 34{,}200 \times 4{\cdot}2 \times {\cdot}00001039 \times Q \div E\,Q$, or

$$\eta = \frac{1{\cdot}45}{E}.$$

Therefore a cell used under such conditions as to require 3·8 volts has an efficiency of 38·2 per cent. The generator described† by E. L. Nichols and G. S. Moler required, under the conditions of their test, 19 volts per cell, the current through each cell being 24·6 amperes. The great efficiency of the generator here described is due to its low resistance; the anodes and cathodes have each 500qcm. area, and the distance between them is 6cm.

One great advantage of a low E.M.F. is that it is impossible for gas to be generated upon the detached sediment of PbO_2, which is gradually formed in the cell. The rapidity of formation of this sediment is, however, not great enough to seriously limit the life of the generator; for during the passage of 1,240 ampere-hours through the generator which was tested the amount of PbB_2 formed was not great enough to be estimated. The test was continued at frequent intervals for more than a month, so that it seems that no serious corrosion of the frames could take place in less than 15 or 20 years of use.

At 15 cents per kilowatt-hour for electrical energy, 660 litres H and 330 litres O would cost about 80 cents, counting four volts per cell of generator. This is sufficient to run a strong limelight for three hours. Counting oxygen only as of value, its cost would be 2·40dol. per kilolitre (about 8 cents per cubic foot). It seems, therefore, with a generator efficiency of 1·45 ÷ 4 = 36 per cent., that the electrolytic generation of H and O for laboratory purposes is not only the most convenient, but perhaps also the cheapest method of production.—*Journal of the Franklin Institute.*

* This point alone has been tested with the finally constructed apparatus. The estimates as to heating and required E.M.F. are based upon the preliminary tests. See below.

† *Physical Review*, vol. i., p. 373.

SOME FAULTS IN ARC-LAMP CARBONS.*

BY W. M. STINE.

There are some features of applied electrics which seem to remain in a condition of arrested development, and share to but a limited extent in the scientific progress made in so many lines. The reference here made is to the arc lamp, and arc-lamp carbons in particular. Regarding the latter, American consumers are content to import the better grades of carbons, while our own makers are unable to supply a competing article. These remarks are made not so much in the spirit of condemnation of existing conditions as in the hope that attention may be attracted to needed remedies.

A series of tests recently conducted by the writer may be offered in illustration. It had been noted that a certain make of carbons gave poor service when burned in one type of arc lamp, but were satisfactory when used with a number of other lamps. Those who have had much experience with constant-potential arc lighting know how frequently such conditions obtain. In order to arrive at an explanation of the facts the tests given below were carried out. They apply to constant potential service in particular.

The carbons were imported, of medium hardness, $\frac{11}{16}$in. in diameter, and cored for the positives and paired with smaller and solid negatives. The faults developed in use were the formation on both tips, but especially on the positive, of small globules. In action these seemed to bridge the arcs, thus short-circuiting the carbons and causing them to "stick." When cooled, the globules were found to be of two kinds; some were dark grey or metallic in appearance, others resembled jet, while all were of such high resistance that a magneto could not be rung through them. The grey globules were of such hardness that they readily scratched glass, and probably consisted in part of silicon carbide. The others seemed to have been formed from residual uncarbonised pitch. Another peculiarity of these carbons was that the usual white coating was very pronounced, extending to a height of several inches above the positive tip, and in some cases was nearly $\frac{1}{16}$in. in thickness. The white fumes had in time penetrated the lamp-case and fouled the works.

The lamps on which these faults were so apparent were of the differential type, and the carbons actuated by a clutch operated conjointly by the series and shunt magnets. Aside from the unsteadiness of the carbon feed usually found associated with the clutch feed in constant-potential circuits, the armature to the shunt coil was long, and ended in a large mass of laminated iron. The great mass and movement of the armature caused it to act somewhat like a heavy hammer, and being actuated by a magnet sensitive to every change in potential distribution in its own and mated arc was in constant motion.

Upon first consideration the faults above noted were attributed to the carbons alone, for it was not so apparent that the lamps were an important factor in producing them. Upon a further investigation it was found that the same carbons were burning with satisfaction in a variety of lamps on similar circuits, developing no unusual faults.

The Tests.—After burning a sufficient number of carbons, to ascertain the frequency with which the faults appeared, readings were taken and plotted as in the figure. Then, in order to further study the lamps, carbons of a variety

* From the *Electrical World* (New York).

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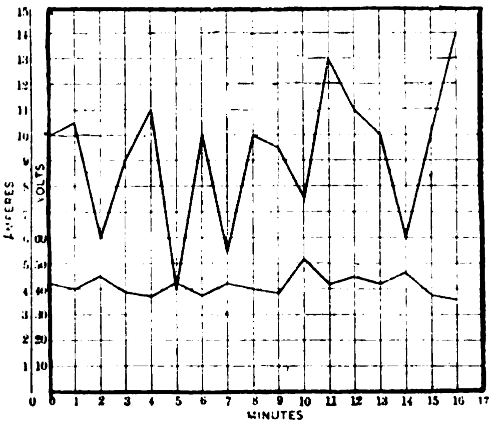
of grades were burned and the readings plotted for comparison. The curves showed sufficient similarity to indicate that the lamps acted about the same, independent of the quality of the carbons. With harder grades of carbons no globules nor excessive coating formed. The source of the globules and coating was next sought. Surmising that they came principally from the material in the core, this was bored out. When burned, the coreless carbon, though much lowered in candle-power, showed but a slight coating and no globules formed.

A comparative study of the behaviour of the carbons when burned in a different type of lamp was next undertaken. The readings when plotted showed the present lamps were taking about the same average current as the others, but the regulation was more gradual, the extreme peaks of current being noticeably absent. The results obtained were a relatively higher candle-power, but slight coating and entire absence of globular formations. It was considered important to study the carbons when burning with practically constant currents. To effect this the carbons were clamped in a fixed position and fed by hand. The currents employed ranged from 10 to 50 amperes. In all cases the carbons showed nothing abnormal, for at a constant temperature due to fixed currents all the products of their combustion vaporised. The grain of the carbon was also tested. This was effected by reducing the carbons by electrolysis, a method already described by the writer. The grain was found to be very fine and practically uniform throughout. The white deposit on chemical analysis showed no unusual constituents, but was largely composed of silicic oxide. The cooled surface of a burned carbon generally showed the presence of a considerable amount of ferric oxide, though by no means an unusual percentage.



Test Curve of Arc Lamp Carbons.

Conclusions.—The opinion seems to be well founded that the faulty behaviour of the carbons was not due to unusual defects either in their composition or manufacture, but rather to the poor regulation of the lamps in which they were burned. On starting these lamps would usually take 29 amperes, while the curve in the figure shows a variation between four and fourteen amperes. Moreover, these variations were both extremely abrupt and frequent. The evidence of the tests just detailed indicated that during the peaks of current the high temperature drove out the uncarbonised pitch, especially from the core, and that the plastic carbon fused with the silicic and ferric oxide impurities. These were followed by a sudden dropping of the current to very low values, cooling the carbons, preventing these substances from volatilising, and passing to the edge of the crater they there assumed permanent form. At times when such globules attained a larger size, they caught the carbons when in near approach and so produced the "sticking" of the arc. When these carbons were burned with a fairly uniform current, the extraneous compounds formed more gradually and were slowly dissipated.

For constant-potential arc lighting it is advisable to use carbons of medium softness for high candle-power, and they must—at least at the present stage of carbon manufacture—be cored.

To those who are constantly testing carbons, it seems that their quality should be greatly improved. Perhaps the manufacturers take a different view, because they do not find improvement either possible or profitable. The ideal carbon should be free from both iron and silicon, and the binding pitch in it should be thoroughly carbonised. The difficulty at present seems to be to prevent the carbons becoming graphitic when so thoroughly carbonised. The difficulty is increased by the use of softer cores, in which a higher percentage of pitch and often alkaline carbonates are employed.

As to the methods of regulation of constant-potential arc lamps, a decided difference of both opinion and practice exists. Some hold that such lamps should be differentially wound, others that only series regulation is efficient. The objection to the use of a shunt coil is that its action is subject to every change in the potential distribution throughout the series of arcs and resistances. The method of feed is perhaps of even greater importance. The feed should be positive, with no retrograde movement except a "take-up" for striking the arc. Any form of clutch which is operated through all the changes of magnetism of the regulating magnet must inevitably produce a continually changing arc. No manufacturer can produce a carbon for high candle-power that will yield satisfactory results with such mechanism. Only very hard carbons should be used in such lamps, the resulting low candle-power being unavoidable.

ALTERNATE-CURRENT TRANSFORMERS.*

BY DR. J. A. FLEMING, F.R.S.

LECTURE III.

The Testing of Transformers.

Having considered the action and construction of transformers, our next duty is to notice the principal facts connected with the testing of transformers. This is a matter of considerable importance. It is not too much to say that in very few alternating-current stations is there any proper system of purchasing transformers to a rigid specification, and enforcing delivery to this specification by efficient methods of electrical testing. Engineers appear to be far too often quite content to accept manufacturers' figures without any confirmation. As an instance of the possible consequences of such a course I may mention that not long ago I had occasion to specify for two transformers on behalf of a corporation; the core loss of these transformers was to be not greater than 550 watts when measured at the proper primary pressure, and on open secondary circuit. When the transformers were delivered they were tested. One of them was found to comply with the specification, the other took up 1,090 watts under the same circumstances. As these transformers were 30-kilowatt transformers, intended to be worked in a sub-station, and to be connected with the mains for at least 4,000 hours in the year, it is perfectly clear that if no test had been applied, and if the transformers had both been accepted, one of these transformers would have taken up 500 watts more than the other. This additional core loss, proceeding for 4,000 hours in the year, would have meant an addition to the magnetising losses of 2,000 Board of Trade units per annum. As this would have involved an expenditure in coal and water of at least one penny per unit, the facts, translated into money, mean that one transformer would cost something like £8 per annum more than the other to maintain magnetised. If this is capitalised at only 3 per cent. it means £240, whereas the actual cost of the transformers did not exceed £140 each. It is clear, therefore, that the omission of a systematic process of testing transformers and of specifying for them for test may involve a supply company or corporation in an increased annual expenditure for maintenance, which under some circumstances may even amount to a considerable sum. In dealing briefly with the subject of testing transformers I shall not attempt to describe all the many different methods which have been suggested, but confine myself shortly to one which is simple, direct, and can be applied in any sub-station or workshop. It should always be remembered that although an electrical method may theoretically give the required result, yet practically it may be difficult to get good results with it on account of the fact that to obtain the necessary accuracy we must assume an unattainable precision in some of the measurements. The method which, after long experience in this matter, I have found most applicable in ordinary cases is one depending on the employment of a properly constructed wattmeter, standard power absorbing resistance, and an auxiliary transformer. We will discuss, in the first place, the construction of each of these instruments separately. If an

* Cantor lectures delivered before the Society of Arts.

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alternating current is sent through a fixed coil of wire, and another current through a movable coil suspended with its magnetic axis at right angles to the first coil, the centres of the coils being coincident, then in general we find an electrodynamic force tending to turn the movable coil from one position to another. If the initial position of the coils is with their magnetic axes at right angles, then the passage of the current tends to displace the magnetic axes so as to make them coincident. If a couple or torque is applied to the movable coil to bring it back to its original position, either by means of a spiral spring or a torsion wire, it can be shown that the couple required to hold the coils in their initial position, with magnetic axes at right angles to one another, is proportional to the mean

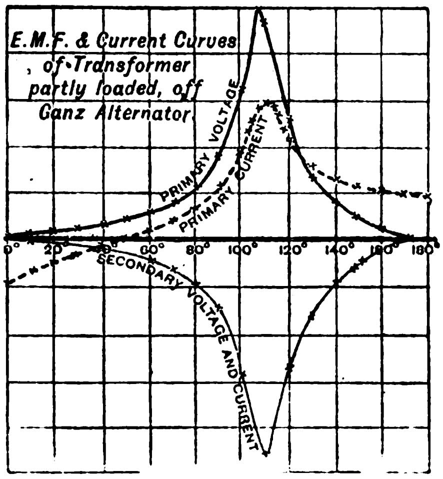

Fig. 34.

value of the product of the instantaneous valves of the two periodic currents passing through the two coils taken at equidistant intervals throughout one complete period. This mean product is therefore at once measured in terms of a mechanical couple. Such an arrangement is called an electro-dynamometer. If the current through one of these coils is the current being supplied to an inductive circuit, say, a transformer, and if the current through the other circuit, say, the movable circuit, can be made to be proportional to the potential difference between the extremities of the inductive circuit, then the dynamometer, now called a wattmeter, will give us when used as above described the true mean value of the product of the instantaneous values of the current through the inductive circuit and its terminal potential difference taken at equidistant intervals throughout the phase; this mean product is a measure of the mean power being taken up at that instant in the inductive

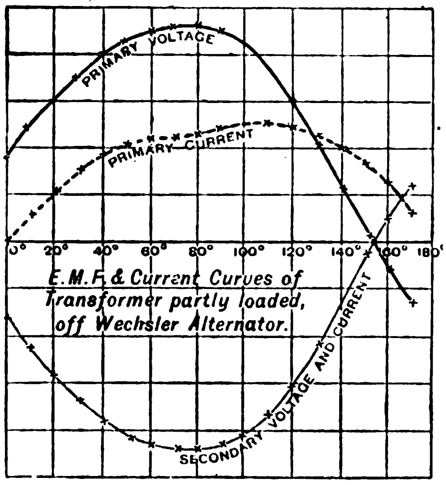

Fig. 35.

circuit, and hence we are able by one measurement to measure this power. In order that good results may be obtained with a wattmeter constructed as above described when employing alternating currents there are certain precautions which must be observed, but which instrument-makers almost habitually disregard. In the first place, the wattmeter must be constructed entirely of non-conducting material. There must be no metal, either iron or brass, in or near the fixed or movable coils. The reason for this is that if metal is placed in this position the alternating currents circulating in the fixed or movable coils set up eddy currents in this metal, and these eddy currents react upon the movable coil, and cause a displacement which creates a false reading. In the next place, in order to make the instrument direct reading it is essential that the fixed coil should be constructed in two parts which are capable of being moved to or from one another, so as to strengthen or weaken the field in the place where the movable coil hangs. In this manner the wattmeter can be adjusted so that a certain angular deflection of the torsion head of the instrument, creating a certain definite couple acting on the movable coil, can be made to mean a certain definite amount of mean power passing through the instrument. Thirdly, precautions must be taken to prevent the effect of the currents in the wires bringing the currents to or from the wattmeter affecting the movable coil. For this purpose these leads ought to be constructed of concentric cable, and the wattmeter carefully tested, before employment, to find out if this cause of error exists. In the next place, we require a non-inductive resistance to act as a standard power-absorber. This can best be made by employing the cages as described in the first lecture. A series of these inductionless resistances—say 20 of

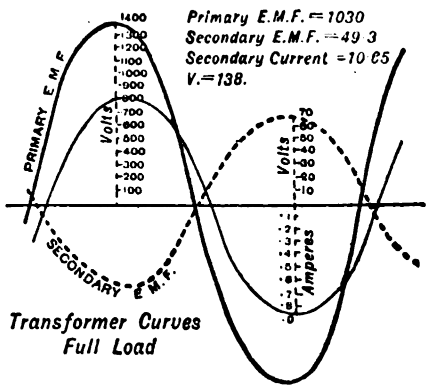

Fig. 36.

them—each capable of withstanding a pressure of 100 volts, are joined up in series, and well insulated. Under these circumstances a pressure of 2,000 volts can be placed on the extremities of this resistance, and a certain current will flow through it. This current can be measured by a sensitive dynamometer, which has previously been calibrated in the usual way. The potential difference between the extremities of the non-inductive resistance when employed on a high-tension circuit is best measured by means of an electrostatic voltmeter. Then lastly, we require an auxiliary transformer for the following purpose. It has been explained in Lecture I. that when a transformer of the closed iron circuit type is worked on a constant-potential primary circuit, the secondary E.M.F. set up in the secondary circuit is exactly opposite in phase to the primary E.M.F. This is further illustrated by the curves in Figs. 34, 35, 36, and 37, which show the primary and secondary E.M.F. curves of a Ganz, a Wechsler, and a Westinghouse transformer in various conditions of load, and it will be seen that the primary and secondary E.M.F. curves

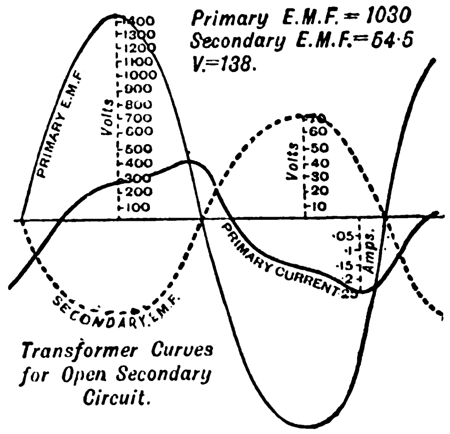

Fig. 37.

are in step with one another but opposite in phase. If, therefore, a transformer has its secondary circuit closed through a non-inductive resistance the secondary current will always be exactly opposite in phase, but proportional in magnitude to the potential difference between the primary terminals of the transformer. In order, then, to make a measurement of the efficiency of any transformer, this apparatus is arranged as as in Fig. 38; the transformer to be tested is denoted by the lines over the words, "Transformer under test." The wattmeter has its fixed coils connected in series with the primary circuit of the transformer to be tested, and its movable coil is connected in series with the secondary circuit of the transformer, which is called the auxiliary or wattmeter transformer, and by including a few incandescent lamps, L,

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in the secondary circuit of this auxiliary transformer, the proper current can be given to the movable coil of the wattmeter. The primary circuit of the auxiliary transformer is connected to the same two mains as the primary circuit of the transformer to be tested, and an electrostatic voltmeter, V, is joined across the primary terminals of the transformer to be tested. The standard inductionless resistance just described is also placed across the primary terminals of the transformer to be tested, and a two-way high-tension switch is arranged so as to throw on the resistance or the primary circuit of the transformer under test at pleasure. A dynamometer is connected in series with this standard resistance to measure the current passing through it. The process of measuring the power supplied to the transformer under test is then as follows: In the first place, we connect to the wattmeter the standard power of absorbing resistance, and observe the current flowing through it, and the potential difference between its extremities. The product of these two numbers in amperes and volts gives us the mean power in watts taken up in the standard resistance. At the same instant a reading of the wattmeter is taken—that is to say, an observation of the amount of torsion required to be given to the wire or spring holding the movable coil to bring it back into its normal position. Let this reading be D_1, and let the power taken up in the standard resistance in watts be represented by W_1. In the next place, the standard resistance is switched off, and the transformer under test is switched on to the wattmeter, and another reading is taken of the wattmeter. Let this reading be D_2. The true power being taken up in this transformer under test is given by the value of the expression $\frac{D_2}{D_1} \times W_1$. In this manner the wattmeter is employed as a kind of electrical steelyard to weigh or measure the ratio between the known power taken up in the standard resistance and the unknown power taken up in the transformer.

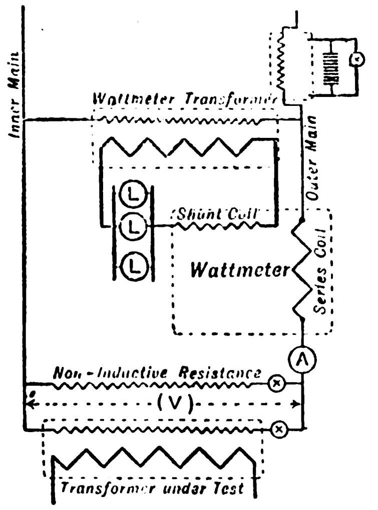

FIG. 38.

A measurement can thus be made with extreme accuracy either in a central station, a transformer sub-station, or a private house. All that it is necessary to do is to connect the wattmeter, in the manner described, in place of one of the primary fuses; that is, to place the series coil of the wattmeter in series with the transformer under test, and then to connect up the standard resistance and the auxiliary transformer, as shown in the diagram. The iron core loss of a transformer on open secondary circuit can thus be quickly and accurately measured, and with a properly-constructed wattmeter of the kind described there is not the slightest difficulty in making the measurement of the core loss of any required degree of accuracy.

The wattmeter before you and the standard resistances have in this way been used for an extensive series of measurements on the efficiency and core losses of the transformers of the City of London Electric Lighting Company. No difficulty was found in making these measurements, even in the small underground sub-stations which are distributed about the City. In addition to the iron core loss of the transformer on open secondary circuit it is also necessary to make two other measurements; one of these is the copper resistance of the two circuits of the transformer when the transformer is warm. The most easy method of doing this is by means of the fall of potential method. When the resistance of the primary circuit is moderately high, say anything over five ohms, it can be very easily measured on the ordinary Post Office Wheatstone bridge, taking the precaution, however, to short-circuit the secondary circuit, but in those cases in which the resistance of either or both circuits is very low then it is best measured in the following manner. A suitable standard low resistance, either 1-100th or 1-10th of an ohm, or one ohm is connected in series with the transformer circuit to be measured, and a small current from a dry cell or secondary battery is sent through this circuit, appropriate resistance being added to increase the total resistance to a proper amount. A movable coil high-resistance galvanometer has its terminals then connected first to the extremities of the standard low resistance, and second to the terminals of the copper circuit of the transformer which is under test. The ratio of these two deflections gives us at once the ratio of the resistance of the transformer circuit to that of the standard low resistance, and in this manner the copper resistance of each circuit of the transformer can be measured. This copper resistance, however, if measured at the ordinary temperature of the air has to be corrected to determine what it is when the transformer has reached its constant temperature. When a transformer is put to work, whether on open circuit or closed secondary circuit, it soon reaches a final temperature which ought never, under any circumstances, to be more than 100deg. C. In order to determine what this temperature is, one of the easiest methods is to connect the transformer on open secondary circuit for five or six hours to the high-pressure circuits, and when the transformer has reached its final and constant temperature to suddenly switch it off, and quickly make a measurement of the copper resistance of the secondary circuit as above described. Then, when the transformer is quite cold, another measurement of the copper resistance may be taken, which will be found to be much less; since the high-conductivity copper employed in transformer manufacture has a temperature coefficient of about 0·4 per cent. per degree C., it is very easy to calculate from these two measurements what is the final and constant temperature of the transformer. Having then measured the copper resistance, and calculated what it will be at the final temperature of the transformer, we have next to measure the secondary drop between full and no load. For this purpose an electrostatic voltmeter is connected across the secondary circuits, and its reading taken when the primary terminal potential difference is also known. The transformer is then loaded up to its full load on its secondary side, and the primary potential difference being kept at the same amount, the secondary potential difference will be found to have fallen, and the amount of difference between its value when the transformer is fully loaded and its value when the

Diagram of Connections for measuring the Drop in Volts of a Transformer.

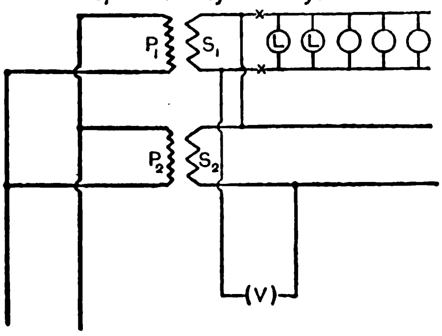

FIG. 39.

transformer is on open circuit is called the secondary drop. It is sometimes difficult to make this measurement with great accuracy, especially when the transformers are working off commercial circuits, but it can always be done in the way shown in the diagram in Fig. 39, if we possess two identical transformers and a low-reading electrostatic voltmeter. The two transformers are connected up with their primary circuits in parallel, and with their secondary circuits opposed to one another through the voltmeter. The voltmeter then reads, not secondary volts to either transformer, but the difference between the two differences. If one transformer is loaded up to full load, the voltmeter will read directly the secondary drop, and since both transformers are affected equally by any variation of the primary pressure, it does not affect their difference, and, therefore, there is no difficulty in getting the measurement with any required degree of accuracy. Having in this manner measured the iron core loss at no load, or on open secondary circuit, the copper resistances when the transformer is warm, and the secondary drop, we have all the information necessary to enable us to make a complete report on the transformer. It has been abundantly shown by experiments which were carried out by me in the year 1892,* that when a transformer is gradually loaded up, the iron core loss is constant at all loads, and that it is only the copper losses that vary. Hence, if we know the iron core loss—that is to say, the loss due to eddy currents and hysteresis in the core when the transformer is on open secondary circuit, we have only to add to this loss the copper losses in the transformer—

* See "Experimental Researches on Alternate-Current Transformers," by J. A. Fleming. *Proceedings* of the Institution of Electrical Engineers, November, 1892.

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that is, the energy losses due to the resistance of the copper circuits—in order to obtain the total power absorption in the transformer at any load. Let P_1 be the total power in watts given in a transformer on the primary circuit, and let P_2 be the total power in watts given out on the secondary circuit to some external resistances, such as lamps. Let I be the total iron losses in the transformer, and C the total copper losses: $P_1 = I + C + P_2$. Hence the difference between P_1 and P_2 is a quantity which can be calculated when we know I and know C, and the efficiency of the transformer is given by the ratio of P_2 to P_1, expressed as a percentage. The copper losses can be calculated with sufficient accuracy in the following manner. Let us suppose that the transformer under test is a 10-kilowatt transformer—that is to say, is constructed to permit 10,000

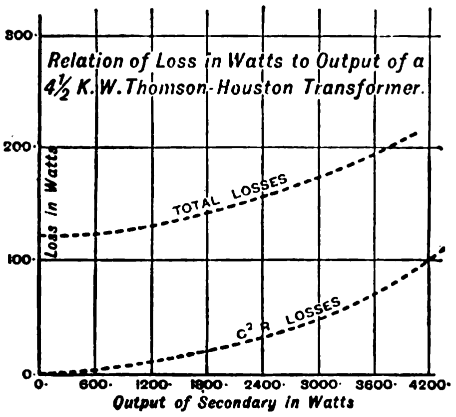

Fig. 40.

watts being taken out from the secondary circuit, and that the secondary watts are intended to be 100. Then the transformer at full load will give out a current of 100 amperes. If we imagine the full load of the transformer to be divided into 10 parts, then when the secondary circuit is delivering 10 amperes at 100 volts the transformer is on one-tenth load, when it is delivering 20 amperes at 100 volts the transformer is on two-tenths of full load, and so on. If the transformation ratio of the transformer is known—that is, the ratio between the secondary volts and the primary volts, or secondary terminal potential difference and primary terminal potential difference, when the transformer is on open secondary circuit—then the primary current can always be calculated with approximate accuracy from the secondary current by simply multiplying the secondary current by the number expressing the transformation ratio. Hence we can calculate the primary and secondary currents corresponding to each decimal fraction of full secondary

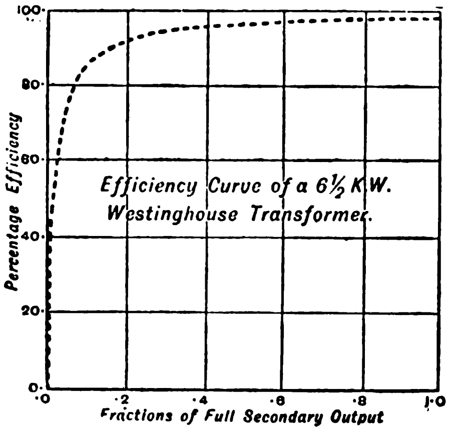

Fig. 41.

load. Knowing the resistances of the two circuits of the transformer when warm we can, therefore, calculate the copper losses in each circuit, because if R is the resistance of a circuit, and C the R.M.S. value of the current flowing through it, then C^2R is equal to the mean power wasted in that circuit. Calculating in this way the total copper losses for the two circuits corresponding to each decimal fraction of the full secondary load, we can add these values to the constant iron core loss experimentally determined, and obtain the total power lost in the transformer, corresponding to each decimal fraction of full load. We have, therefore, the difference between P_1 and P_2, corresponding to known values of P_2. Hence, we can calculate the ratio of P_1 to P_2 for each decimal fraction of the full secondary load, and, therefore, we have the efficiency of the transformer, and the total loss in the transformer given to us at each fraction of the full secondary load. This is by far the best method of determining the efficiency of very large transformers, because it does not necessitate loading up the transformer to its full load on an actual resistance; and even if this can be done the measurement which we actually require is the difference between two large observed quantities, and is, therefore, very liable to be affected by an error in either of them. Having obtained in this manner the total losses in the transformer for the various decimal fractions of the full secondary load, the most convenient graphic method of representing the results is by a total loss diagram. A horizontal line is taken, and is divided into 10 equal parts representing the decimal fractions of the full secondary load. At each part a vertical line is set up, representing the total losses in the transformer, both the copper and the iron losses, and two curves are drawn, as in Fig. 40, one representing the variation of the total copper losses in the transformer with the secondary load, and the other representing the constant iron loss at all loads. From this curve another curve, called the efficiency curve, can be drawn in the following manner (see Fig. 41). A horizontal line is taken representing the secondary output, and divided into 10 equal parts representing the decimal fractions of the full secondary load. At each point a vertical line is set up representing the ratio between the power given out by the transformer to the power taken in by the transformer, expressed as a percentage, and the curve delineated by these points gives us the efficiency curve of the transformer. In a well-designed transformer this efficiency curve is a square-shouldered curve, rising very rapidly up to 90 per cent. at one-tenth of full load, and to 96 or 97 per cent. at full load. A fairly good estimate of the value of a transformer, from an efficiency point of view, can be obtained by taking its efficiency at one-tenth of full secondary load. Even quite small transformers are now made which have an efficiency of 80 per cent. at one-tenth of full load. Large transformers of 30 to 50 kilowatts and upwards can be made to have an efficiency of 90 per cent. at one-tenth of full load. Ten years ago it was difficult to get any transformer having more than 40 to 50 per cent. of efficiency at one-tenth of full load.

It should be noted, however, that the form of this efficiency curve, as well as that of the current curve, depends upon the nature of the curve of primary E.M.F. The diagram in Fig. 30, Lecture II., shows the difference which may exist in the efficiency curves in the case of the same transformer tested in two different alternators, a Ganz and a Wechsler.

In considering the performance of transformers, we are not only concerned with the instantaneous efficiency—that is, the efficiency under any particular load—but with what is called the all-day or all-year efficiency. This can be calculated when we know the efficiency of the transformer at various loads, and when we know the nature of the load diagram, as it is called, on which the transformer is supplied. Thus, for instance, let us make the assumption that the load diagram of a transformer is a 10 per cent. load diagram—that is to say, let us assume that out of the 24 hours for 11 hours the transformer is giving no current from the secondary circuit, for five hours is supplying at one-tenth of its full secondary output, for four hours one-eighth, for three hours one-quarter, and for one hour three-quarters. It will be found, on adding up these outputs, that they amount to one-tenth of that which the transformer would be supplying if working at its full secondary output for the whole 24 hours. Let us take, then, the case of a 20-kilowatt transformer having 1·35 per cent. loss on open secondary circuit and 1·35 per cent. – 1·60 per cent. loss at full load. This gives an open circuit loss of 324 watts at no load—that is to say, 324 watts is the core loss in the transformer at no secondary load; the efficiency at one-tenth full load is 86 per cent., and at full load 96 per cent. From the total loss diagram it can then be shown that the transformer takes up in its primary circuit 324 watts on open secondary, 2,762 watts at one-tenth of full load, 3,372 watts at one-eighth of full load, 6,420 watts at one-fourth full load, and 18,162 at three-fourths of full load. We can then construct an energy balance-sheet for the transformers as follows, putting on one side the energy in watt-hours given by the primary circuit, and on the other side the energy in watt-hours taken from the secondary circuit, and these figures will be as follows:

Energy in Watt-hours given to Primary Circuit.

11 × 324 = 3,564
5 × 2,762 = 13,810
4 × 3,372 = 13,488
3 × 6,420 = 19,260
1 × 18,612 = 18,612
Total = 68,734 Board of Trade units.

Energy in Watt-hours taken from Secondary Circuit.

11 × 0 = 0
5 × 2,400 = 12,000
4 × 3,000 = 12,000
3 × 6,000 = 18,000
1 × 18,000 = 18,000
Total = 60,000 Board of Trade units.

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It will be seen, therefore, that the total Board of Trade units given in the primary circuit in the 24 hours are 68,734, and the total Board of Trade units taken from the secondary circuit in 24 hours are 60,000. The secondary output is, therefore, 87 per cent. of the primary intake, and this is called the all-day efficiency of the transformer on that old diagram. It is not very far from the instantaneous or actual efficiency of the transformer at one-tenth of full load. It will generally be found that the actual efficiency at one-tenth of full load is a very fair guide to the all-day efficiency on a load having a load-factor of 10 per cent.

(To be continued.)

LEGAL INTELLIGENCE.

ELECTRICAL EXPERIMENTING.

At the Westminster County Court, on Tuesday, before his Honour Judge Lumley Smith, Q.C., the case of Holt *v.* Blenheim was heard.

The plaintiff, a dealer in electrical plant and machinery, sued the defendant to recover £6 in respect of four weeks' hire of a dynamo. It appeared that the defendant was desirous of carrying out some electric light experiments, and for that purpose he borrowed the dynamo from plaintiff. The defendant had made a payment in respect of a former hiring, and the present claim was in respect of additional hire over and above the specified time.

The defence was that the defendant was not personally liable, and machine was hired for a third party.

After hearing evidence at some length, his **Honour** said he was satisfied that the defendant was liable, and gave judgment for the sum claimed, with costs.

COMPANIES' MEETINGS AND REPORTS.

EDISON AND SWAN UNITED.

The thirteenth ordinary general meeting of the Edison and Swan United Electric Light Company, Limited, was held on Friday last at Cannon-street Hotel, E.C., Mr. James Staats Forbes (chairman of the Company) presiding.

The **Chairman**, in moving the adoption of the report, a copy of which appeared in our last week's issue, said it was necessary for him to be somewhat reticent regarding the business, for if he gave a great variety of details he would be only arming their opponents. Their business was progressing in bulk, although, under the necessity of competition, there was a diminution in the profit on many things. The year's working had given them a credit balance of £27,526, and, after providing the interest on the debentures—the price of the purchase of the Swan residuum—there was enough money to pay 5 per cent. on the A capital and to carry forward a considerable balance. They could pay a larger dividend than 5 per cent., only they did not think it would be prudent to do so in existing circumstances. They thought that 5 per cent. would be a very good dividend to maintain until they saw that they could safely pay more. As he had said, the competition had been and was severe, although it was a little less serious now. The Edison and Swan lamp had a certain reputation, and a great many were committed to use it, but some of them were naturally tempted by the offer of lamps—one lamp was very much like another so far as external appearance went—at a lower price. However, lamps, like friends, could only be tested by experience, and those who tried those cheaper lamps soon gave them up and came back to the Ediswan ones. That was a process constantly going on. The competition in the price of fittings, etc., was very keen, and in lamps and fittings the bulk of their trade had been done. Then the cost of materials had gone against them ; the price of platinum, brass, and some other things had been higher. They had a strike also in the early part of the year, which disarranged their affairs. There were the usual consequences of a strike. Those who made it were a long time out of work and lost a lot of money. The strike opened the eyes of the Board to the necessity of finding some method of making themselves independent of the class of people who caused the strike. It was now done with, but it necessarily affected adversely the result of the year's working. That was about the whole story of the year. After recapitulating some of the items of the accounts the Chairman said the directors had enjoyed in the past the usual sweets of experience—early blunders and errors—but had been utilising the knowledge gained. They knew now what was the worst that could befall them in the future, and what they knew justified a strong belief that the Company might be made still more prosperous, and be in a position to increase its operations to an extent that would benefit the shareholders considerably. Mr. Swan, who was about the largest shareholder in the Company, had staked his reputation upon it by keeping a large fortune in the Company. Though a great scientist and inventor, he was at the same time an extremely good man of business, and he did not apprehend much danger of his property or his dividends diminishing in value. He (the Chairman) felt the same.

Mr. J. W. Swan seconded the resolution, which was carried unanimously.

The **Chairman** moved that a dividend be declared on the "A" shares of the Company at the rate of 5 per cent. per annum in respect of the six months ending June 30, 1896, making, with the interim dividend paid on February 18, 1896, 5 per cent. on the "A" share capital of the Company, as now paid up in respect of the year ending June 30, 1896.

Mr. Ernest Villiers seconded this.

Mr. K. Hedges, while congratulating the directors on the result of the year's trading, said that it had struck him that the lamp business was not so profitable as it might be. He thought the directors might do more than they did in the way of advertising their goods. As an electrical engineer, he was inundated with circulars from lamp manufacturers urging him to recommend their goods. In conclusion, he expressed surprise that the shares of the Company stood at so low a price in the market; at the present price they paid 10 per cent. to a purchaser of them.

The **Chairman**, in reply, said it was quite true that advertising oneself and one's wares was a very popular thing nowadays, but there were various ways of doing it. The Company relied on the fact that they produced a good lamp, and that people who made installations knew that it was so. As to other advertising, he would remind Mr. Hedges that in every London hotel and in every bedroom of those hotels advertisements of the Company's goods were to be found.

The resolution was then put, and carried unanimously.

The retiring directors, Major Flood Page and Mr. J. W. Swan, were re-elected, and Messrs. Welton, Jones, and Co. reappointed auditors.

WATERLOO AND CITY RAILWAY COMPANY.

The half-yearly general meeting of this Company was held at Waterloo Station yesterday (Thursday afternoon), Mr. Wyndham Portal presiding.

The directors' report stated that the arrangement with respect to the City terminus had been completed, and the necessary agreement executed between the Company and the Central London Railway Company.

The engineers, in their report, stated that the plans for the generating station were being prepared, and would be ready for letting the contract shortly after the holidays.

On the motion of the **Chairman**, the report was adopted.

NATIONAL TELEPHONE COMPANY, LIMITED.

The eighteenth ordinary general meeting of this Company was held on Thursday afternoon last at the Cannon-street Hotel, and a brief report appeared in our last issue, together with the directors' report and accounts.

Mr. J. S. Forbes (the chairman), in moving the adoption of these, said, as the report stated, a not inconsiderable outlay had been attributable to the substitution of metallic circuits for single lines, and the construction of underground works in lieu of overhead wires. Of this amount £45,000 had been expended in Manchester during the half-year, thus greatly improving the efficiency of the service for existing subscribers, and providing a large additional amount of capacity for increased business. When the system was in full work it should involve a much less annual charge for maintenance. In London also they were just entering upon some work of the same kind, which was wanted for the service of the Metropolis. He would like to repeat what he had said before, that the Company had to expend three years' subscriptions received from each subscriber before they touched a farthing of his money. This was a great risk, and he would make a present of the information to those who might be contemplating the establishment of competing businesses in London. They were spending money at a very rapid rate—last half-year £240,000, and a similar sum in the current half-year, making about half a million of money. The result showed that the capital account was in debt £210,000. The other side of the accounts showed that during the last half-year they had expended on lands, buildings, and machinery £44,850. They had spent that amount of the reserve fund, and altogether they had spent in Dublin, Leeds, London, Birmingham, Bradford, and Manchester a total amount up to the present time of £208,000 on land and buildings. The report dealt with the transfer of trunk lines to the State. In accordance with the agreement arrived at, these had been surrendered to the Post Office on April 4 last, in consideration, among other things, of the payment of their value as fixed by experts, after an elaborate and prolonged enquiry. The transfer had naturally involved some inconvenience in connection with the through telephone business of the country, but as the Post Office authorities and the Company's officers were loyally co-operating with the object of securing the most efficient possible service it was hoped that the inconvenience might be speedily terminated. In place of Sir Henry Calcraft, deceased, the Board had elected the Right Hon. Sir James Fergusson, who as Postmaster General, initiated the present telephone system. He need hardly point out the advantage of having the aid of such a director.

Lord Harris seconded the resolution.

There were some remarks from **Messrs. Galbraith, Hall, Leake,** and others, and

The **Chairman**, in reply, said that they had received the amount due to them for the trunk wires, and they were satisfied with the bargain they had made. With reference to the reserve fund, it was most important for the shareholders to remember that the Company would cease to have any life at the end of 16 years. They therefore had to bear in mind the possibility that their

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values of so many-millions in the balance sheet might not be realisable at the end of the term. As to the amount of the dividend, if at the end of the current half-year they found that they could prudently pay a dividend of 6 per cent. they would do so. The proposed pension fund was based on a 15 years' tenure. The theory was that the Government would take over their employés with the telephone at the end of the Company's term, but their obligation in any case was limited to 15 years.

The resolution for the report and dividends was unanimously adopted, and the appointment of Sir J. Fergusson approved.

ELECTRIC CONSTRUCTION COMPANY, LIMITED.

Directors: Sir Daniel Cooper, Bart., G.C.M.G., chairman; James William Barclay, deputy chairman; Philip Edward Beachcroft; John Irving Courtenay; Sir Henry C. Mance, C.I.E.; James Pender, M.P. Manager: A. B. Blackburn, M.I.C.E. Secretary: James Gray.

Report of the directors to be submitted to the shareholders at the third annual general meeting of the Company to be held at Winchester House, Old Broad-street, London, E.C., on August 27, 1896, at 2 30 p.m.:

The net profit of the year, after paying interest and general expenses, providing for the full maintenance of buildings and plant, and appropriating £5,000 to depreciation account, is £16,450. 9s. 11d. Adding to this amount the credit balance of £10,134. 15s. 10d. from last year the sum available for dividend is £26,585. 5s. 9d., whereof the directors recommend that £2,288. 0s. 5d. be applied in payment of the dividend on the preference shares on September 1 next, and £11,000 in payment of a dividend of 5 per cent., free of income tax, on the ordinary shares, one-half on September 1 next and the other half on March 1, 1897, and that the balance, £13,297. 5s. 4d., be carried forward to the credit of next year. The gross manufacturing profit has increased from £31,814. 12s. 7d. in 1895 to £41,353. 1s. in 1896. The output of the works shows a considerable increase on that of the previous year, and the Company's high reputation for excellence in design and quality of workmanship has been fully maintained. The factories are now full of orders at fairly remunerative prices. To meet the demands of the growing business a considerable addition has been made to the buildings and plant at Bushbury, and these extensions, recently completed, will not only facilitate prompt execution of orders, but also tend to economy in production. Among the more important works completed during the year, or now in progress, may be mentioned orders from the War Office and Crown Agents for the Colonies, and plant for various central stations, including Shoreditch, Clerkenwell, Leyton, Durban, and the Hartlepools Electric Tramways. The directors who retire by rotation at the general meeting are Sir Henry Mance and Mr. Philip Edward Beachcroft. They are eligible for re-election. Messrs. James Meston and Co., the auditors for the past year, offer themselves for re election.

PROFIT AND LOSS ACCOUNT, YEAR ENDED JUNE 30, 1896.

Expenditure.				£	s.	d.
Interest on loans and debentures paid and accrued				12,421	5	9
Salaries to staff in head office and works	£9,093	3	7			
Rents, rates, and taxes at head office and works	1,071	1	5			
Insurances	233	0	1			
Advertising	816	16	9			
Travelling expenses	931	12	0			
Patent fees and royalties	738	15	2			
Law charges	113	1	10			
Printing and stationery, postages and telegrams	689	13	10			
Commissions and agency charges	190	10	6			
General expenses, bank charges, stamps, etc.	826	8	10			
Fees and expenses of trustees under first and second mortgages	215	4	0			
Auditors' fees	120	0	0			
Directors' fees	1,500	0	0			
				16,539	8	0
Maintenance of plant and buildings	1,165	6	7			
Depreciation account—amount set aside this year	5,000	0	0			
				6,165	6	7
				35,126	0	4
Net profit				26,585	5	9
				£61,711	6	1

Income.				£	s.	d
Amount brought forward from last year				10,134	15	10
Gross profit on manufacturing and contracting	£41,353	1	0			
Rents, profit on maintenance contracts, premiums from pupils, and sundry profits	5,030	19	9			
Interest and dividends on debentures and shares of other companies	5,142	17	0			
Transfer and registration fees	49	12	6			
				51,576	10	3
				£61,711	6	1

BALANCE-SHEET, JUNE 30, 1896.

Capital and Liabilities.				£	s.	d.
Capital issued—110,000 ordinary shares of £2 each, fully paid	£220,000	0	0			
16,343 cumulative 7 per cent. preference shares of £2 each, fully paid	32,686	0	0			
				252,686	0	0
Debentures issued—first mortgage 6 per cent. debenture bonds, authorised issue £150,000 (200 ditto, issued and deposited as security, £20,000)	129,900	0	0			
Second mortgage 6 per cent. debenture bonds, authorised issue, £100 000, current at July 1, 1895, £44,690; less drawn and paid off during year, £2,460	42,230	0	0			
				172,130	0	0
Loans (secured by deposit of £20,000 first mortgage debentures, and of shares and debentures in other companies)				115,500	0	0
Sundry creditors	24 033	0	5			
Debenture interest accrued	4,901	11	6			
				28,934	11	11
Bills payable				1,780	4	1
Amount at credit of depreciation account, per last account	8,000	0	0			
Credited from profits for year 1895-6	5,000	0	0			
				13,000	0	0
Net profit				26.585	5	9
				£610,616	1	9

Assets.	£	s.	d.
Freehold and leasehold land and buildings at Bushbury (Wolverhampton) and Millwall; plant, machinery, tools, and patterns at works; patents and goodwill, as per last account	303,975	15	7
Additions to plant and furniture during the year	4,018	7	3
Additions to buildings during the year	3,470	2	10
	311,464	5	8
Shares and debentures of other companies*	134,930	4	11
Sundry debtors (after providing for bad and doubtful debts)	92.057	5	2
Trustees of first mortgage debentures—price of property sold	2,500	0	0
Bills receivable	985	11	3
Work and contracts in progress—cost	31,484	15	4
Stock—finished goods and materials on hand—cost	26,315	0	8
Cash at bankers and in hand	10.878	18	9
	£610,616	1	9

* Note.—There is a contingent liability in respect of amounts uncalled on certain of these shares.

CENTRAL LONDON RAILWAY COMPANY.

The report of the directors for the half-year ending June 30, 1896, states that the expenditure during the half-year has amounted to £273,812. 14s. 9d., which, added to the amount previously expended, makes a total outlay of £442,098. 0s. 11d. The further payments for property and works required during the next few months has rendered a call upon the shareholders necessary, and accordingly a call of £2 per share, payable on September 1 next, has been made. Representations have from time to time been made to the effect that it would be a convenience to proprietors desiring to do so if they could be allowed to pay up in full the uncalled capital on their shares in advance of calls, and the directors have decided, until further notice, to accept such payments in advance, and the necessary form of application can be obtained from the secretary. It will be seen from the report of the engineers that satisfactory progress has been made with the works. The contractors have now obtained possession of station sites at Shepherd's Bush, Holland-park, Notting Hill-gate, Westbourne, Marble Arch, Oxford-circus, Tottenham Court-road, British Museum, and Chancery-lane. It has been considered expedient to enlarge the Post Office Station in Newgate-street, and there will consequently be some delay in acquiring the additional property which will be required for that purpose. The Great Eastern Company has approved the plans prepared by the engineers for the station at Liverpool-street, and it is hoped that an agreement satisfactory to all parties may soon be completed. The North London Company has also approved plans providing for a public access from Broad street Station to the Liverpool-street Station of the Central London Company, and agreement is in course of preparation in connection therewith. The resolutions for the division, if thought fit, of the shares into "preferred half-shares" and "deferred half-shares," which will be submitted at an extraordinary general meeting to be held at the conclusion of the half-yearly meeting, are set out in the notice convening the meeting. The rate of interest payable on the capital from time to time paid up will not be affected by the proposed division, if adopted, so long as the line is in course of construction. The interest will remain during that time at the rate of 3 per cent. per annum, in accordance with the provisions of the Act of Parliament. The preference dividend of 4 per cent. proposed to be assigned to the "preferred half-shares" will not

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come into force until the railway is completed and opened for traffic. The following is the clause in the Central London Act, 1891, relating to the division of shares: "Subject to the provisions of this Act the Company, with the authority of three-fourths of the votes of the shareholders present in person or by proxy at a general meeting of the Company specially convened for the purpose, may from time to time divide any share in their capital into half shares, of which one shall be called 'preferred half share,' and the other shall be called 'deferred half-share,' but the Company shall not so divide any share under the authority of this Act unless and until not less than 60 per cent. upon such share has been paid up, and upon every such division 50 per cent. upon the entire share shall be carried to the credit of the deferred half-share (being the whole amount payable thereon), and the residue to the credit of the preferred half-share." The report is signed by the chairman, Mr. Henry Tennant. The shareholders' meeting takes place at Cannon-street Hotel on August 11.

The engineers' report alluded to above is signed by Messrs. Fowler, Baker, and Greathead, and is as follows: We have to report that possession has now been obtained of the station sites, with the exception of Queen's-road, Davies street, and Newgate-street. The construction of the Bank Station has been commenced, and good progress has been made with the shafts at Shepherd's Bush and Chancery-lane stations. Satisfactory progress has been made with the preparation of the ironwork for the tunnels throughout the whole length of the line and of the shields and other appliances for the execution of this work.

IMPERIAL TRAMWAYS COMPANY, LIMITED.

The report of the directors of this Company for the half-year ended June 30 states that the receipts of the Corris Railway continue satisfactory, and the profit earned admits of a dividend of 5 per cent. per annum on the ordinary stock all of which is owned by the Imperial Company. The total receipts of the Middlesbrough Tramways amount to £3,303, and the expenditure £2,579, showing a profit of £724. The gross receipts of the Reading Company have been £3,566 whilst the expenditure was £2,803, the profit being £763, or sufficient for a dividend at the rate of 6¾ per cent. per annum on the capital. The directors have for some time past had in preparation proposals for the conversion of the Reading tramways into electric lines and concurrently extending the tramways into other parts of the town. These proposals will in due course be submitted to the Town Council for consideration and the necessary powers applied for. The directors recently informed the shareholders that they had succeeded in disposing of the Company's interest in the Dublin Southern District Tramways Company, and their estimate of £106,000 as the net purchase-money is approximately correct. A deposit of £30,000 has been received from the purchasers, and the balance of the purchase money is payable on or before December 31 next. The shares will only be transferred by the Company against receipt of the balance of purchase-money. The gross revenue, omitting all credit on Dublin account, amounts to £1,892 and the net profit to £1,695, adding to which the balance brought forward (£654. 11s. 4d.) a total of £2,349 is available Of this sum, £624 has been absorbed in debenture interest and the directors recommend the appropriation of the remainder as follows: to preference dividend at 6 per cent. per annum, £350; ordinary dividend at 2½ per cent. per annum, £1,333; and to carry forward £42. During the half-year £4,450 debentures were allotted, thus completing the whole issue. The shareholders' meeting takes place at Bristol on Saturday.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Odessa.—The Municipal Authorities will receive tenders up to August 13 for street electric lighting and for the lighting of the new prison.

Oldham.—The Corporation want tenders by 18th inst. for an electric feed-pump. Particulars from Mr. Andrew, Gas and Water Offices, Oldham.

Nava del Rey (Spain).—The Municipality are open to receive tenders up to August 28 for the electric lighting of Nava del Rey for a period of 20 years.

Bucharest.—Tenders are wanted by August 19 for the electric lighting of the Boulevard Coltea. Application should be made to the Mairie, at Bucharest.

Dortmund (Germany).—The Municipal Authorities of Dortmund want tenders by September 1 for engines, boilers, and dynamos for the electric lighting of the town.

Cassel (Germany).—Tenders are wanted by the Slaughter-house Committee for an electric lighting installation of 80 incandescent and 14 arc lamps. The date is August 15.

Paris.—Tenders are wanted by August 14 for erecting lightning conductors. The estimate is about £400, and application should be made to l'Assistance publique, avenue Victoria 3, Paris.

Vich (Spain).—The contract will be allotted by the municipal authorities of Vich on August 17 for the electric lighting of the town for 10 years from June, 1897. The annual payment proposed is about £800.

Hampstead.—Tenders are wanted for the supply and erection of 80 arc lamp columns about 19ft. high, for the Hampstead Vestry. Particulars are obtainable at the Vestry's Electric Department Offices, 57, Pratt-street, Camden Town, N.W., and tenders must be in by August 24.

Islington (London).—The Vestry require tenders for the enlargement of their central electric lighting station, Eden-grove, Holloway-road, N. Application should be made to Mr. Wm. F. Dewey, vestry clerk, Vestry Hall, Upper-street, Islington, N., with a deposit of £5, before August 10.

Halifax.—Firms desiring to tender for the electric lighting and hoists at the new infirmary to be built for the Guardians of the Halifax Union must apply before August 13 to the architects, Messrs. Horsfall and Williams, George-street and deposit two guineas with the Clerk to the Guardians, Union Offices, Halifax.

Dundee.—The Gas Commissioners invite tenders for the supply of indiarubber-covered cables for electric lighting in the Overgate, Wellgate, and Whitehall-street districts of the city. Particulars as to quantities, etc., can be had from the Electrical Engineer, Dudhope-crescent-road, Dundee. Tenders to the Clerk of the Commissioners, City Chambers, Dundee, by 19th inst.

Simla (India).—The Municipality is inviting tenders for lighting by electric light for a term of years the principal thoroughfares and buildings belonging to the Municipality. Tenders must be submitted by September 1 next. Should any proposal be accepted, the Municipality will afford the successful tenderer all facilities to extend the system of lighting to private houses.

Cologne.—Tenders are required by the Municipal Authorities for the construction and working of electric tramways in the city of Cologne to an aggregate length of 20·3 kilometres (12½ miles). Specifications, plans, and particulars are obtainable for 10 marks (10s.) from der Registrateur B, des Oberbürgermeisteramt, Köln, Germany, and tenders must be in by November 6.

Madras.—Tenders are invited for the lighting by electricity of Government House, Madras, including the banqueting-hall and aide-de-camps' bungalow, and also for the lighting of Government House, Guindy, including the military secretary's bungalow. For particulars application must be made to the consulting architect to the Government, Chepank, Madras. Tenders will be opened on November 11, 1896.

Radcliffe.—The District Council invite tenders for the supply and erection of a gas-engine and dynamo and the fitting up and lighting of the Technical School by electricity. A copy of the plans, sections, and specifications may be obtained on payment of 10s. 6d., and forms of tender obtained from the Surveyor, Council Offices, Radcliffe. Sealed and endorsed tenders to be sent to Mr. J. Sharples, clerk by 17th inst.

Voghera (Italy).—In view of the expiration of their contract with the local gas company in 1898, the municipal authorities of Voghera are desirous of receiving during the present year propositions for the lighting of the town either by the electric light or a mixed system of gas and electricity. The population is 16,000. Application should be made to L'Administrazione Comunale, Voghera, who will give all particulars necessary.

Mayaguez (Puerto Rico).—The Secretary of State for Foreign Affairs has been informed by H.M. Ambassador at Madrid that the Spanish Government have invited tenders for the construction and working of a telephone system in Mayagüez, Puerto Rico. The date fixed for the consideration of tenders is October 8, and such particulars as have been received may be inspected at the Commercial Department of the Foreign Office between the hours of 11 and 6 daily.

Mexico.—The municipal authorities of the city of Mexico are prepared to receive proposals for the street lighting by incandescent lamps for a period of eight years. Tenders should be sent in by August 31. The Secretary of State for Foreign Affairs has received from the British Consul at Mexico a pamphlet issued by the Municipal Council of the city containing particulars as to the tenders, and this may be seen on application to the Commercial Department of the Foreign Office between the hours of 11 and 6. The plan as laid out accounts for 480 arc lamps of 2,000 c.p. each, and 120 of 1 200 c p., to which are added 150 incandescent lamps.

Southampton.—The Harbour Board invite tenders for the construction and erection of four electric cranes and accessories, and also for alterations to a gantry of an existing crane, on the Town Quay, Southampton. Specification, with two general drawings attached, may be obtained on and after 20th inst. from Mr. A. H Skelton, clerk, Town Quay, Southampton, upon payment of £3. 3s, which will not be returned, and further detailed plans may be seen at the office of the electrical engineer, Mr. J. G. W. Aldridge, 9, Victoria-street, Westminster, S.W. Sealed tenders, marked "Tenders for Electric Cranes," should be sent to the clerk by August 31.

Manchester.—The Gas Committee require tenders for the construction of an underground electric lighting sub station in Piccadilly The general conditions of contract, bills of quantities, and forms of tender can be obtained on application in writing to Mr. C. Nickson, superintendent, Gas Department, Town Hall, Manchester. A deposit of £1. 1s., which will be returned on receipt of a bona fide tender, must accompany each application for a tender form. Sealed tenders, addressed to the Chairman of the Electric Light Sub-Committee, and endorsed "Tender for Underground Sub-Station," must be delivered at the Gas Office, Town Hall, by 10 a.m. on August 8.

Jassy.—The Mayoralty of the Town of Jassy (Roumania) has given notice that on August 23, 1896, old style (by our reckoning September 4), tenders will be received, for the second time, in the hall of the Municipal Council, for "the installation of a frigorific

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hall, electric light, and various accessories requisite for new public slaughter-houses. Offers must be in accordance with the specification, the conditions of contract, the special conditions, and the plans deposited in the offices of the director of the slaughter house works, where particulars may be obtained." Tenders are to be enclosed in sealed envelopes, marked "Offre pour l'installation de la Hall Frigorifique," and senders of tenders must abide by articles 68-79 of the Roumanian Public Accounts Act. All tenders and supplementary documents must be in either the Roumanian or French language.

Bath.—The Corporation invite tenders for the supply and erection of the following plant:—Section A: Boiler and fittings, feed pump, etc. Section B: Steam alternators, oil-filter, fittings, etc., steam, exhaust, feed, blow-off, and sundry pipes, valves, etc. Section C: Mains. Section D: Crane. Section E: Arc lamps and posts. Tenderers are at liberty to tender for either section, but not for part of a section. The ground plan of plant and specification, with terms and conditions of tender and contract, may be obtained at the office of Mr. Robert Hammond, the consulting engineer, Ormond House, Great Trinity-lane, E.C., on and after the 13th inst., on payment of £2. 2s., which will be returned on receipt of a bona fide tender. Sealed tenders, marked "Tender for Electric Lighting," must be addressed to Mr. F. H. Moger, clerk, 3, Wood-street, Bath, and delivered by the 31st inst.

RESULTS OF TENDERS.

Bath.—The Baths Committee have accepted the tender of Messrs. Laing, Wharton, and Down, London, for the electric wiring of the Pump-room extension, at £273.

Wolverhampton.—The Town Council have decided to accept the tender of Messrs. Thomas Parker, Limited, for rewinding four armatures, altering magnets of transformers, and supplying starting resistances, at a total cost of £955. 10s.

Leeds.—The tender of Messrs. Laing, Wharton, and Down for trolley wire and attachments for the Roundhay and Kirkstall tramway, at the sum of £5,740, has been accepted by the Town Council. This tender is £120 more than that of Messrs. Siemens, which was withdrawn.

St. George's, Hanover-square (London).—The Vestry have accepted the tender of Messrs. Ridout and Co., of 124, Regent-street, at £39. 15s., for wiring and supplying fittings for the Pimlico road offices, subject to an alternative price being obtained for utilising the existing fittings in the Board-room.

Bolton.—The contract has been placed with Messrs. Drake and Gorham for the large extension of the electric lighting at Messrs. Tootal, Broadhurst, and Lees's Daubhill Mills. Messrs. Drake and Gorham have also been successful in obtaining the contract for the lighting of the works of Strine's Printing Company, in Derbyshire.

BUSINESS NOTES.

Direct Spanish Telegraph Company.—For the month of July the receipts were £1,950.

Western and Brazilian Telegraph Company.—For the past week the receipts were £2,608.

New Address.—Messrs. Hailey and Co. have removed from Sloane-street to Pentagon Works, 30 Pavilion-road, S.W.

Linesmen.—The Postal Telegraph Linesmen and Mechanics' Association of the United Kingdom have held their first meeting at Manchester.

Gisburn (Yorks).—A suggestion has been made locally to utilise water power near at hand for the purpose of lighting the village electrically.

Cuba Submarine Telegraph Company.—For the half-year ending June 30 the directors recommend a dividend at the rate of 8 per cent. per annum.

West India and Panama Telegraph Company.—For the half-month ended July 31 the receipts were £1,920, as against £1,866 for the corresponding period of 1895.

Sale.—The clerk has reported to the District Council that the order for the electric lighting of the district had received Royal assent, and was in possession of the Council.

Wolverhampton.—The Town Council have decided to apply to the Local Government Board for sanction to borrow £600 for the purchase of an additional transformer.

Ambulance Work.—The Liverpool Overhead Railway Ambulance Society had a tournament in the grounds of the Merchant Taylors' School, Crosby, on Saturday last.

Worcester.—A dedication service has been held for the Hope Jones electrical organ in the cathedral. A short description of this has already been given in these columns.

Plymouth.—The Electric Lighting Committee have adopted Mr. Rider's report and scheme for lighting and power supply, and recommend that £45,000 should be borrowed to carry it out.

Dublin.—A resident in Monkstown has written to the local Press complaining that the electric tramcars do not run so fast as they used to at first. He suggests fixed stopping points to save time

Bristol.—Colonel Marsh, R.E., one of the Local Government Board inspectors, has held an enquiry into the application of the Bristol Corporation to borrow £75,000 for electric lighting purposes.

Southwark (London).—The St. George's Vestry have agreed to the National Telephone Company laying their mains underground, on condition that the company pay a rental of £500 per annum to the parish.

Esh (Durham).—A committee meeting has been held to consider a proposal to light two of the wards of the parish—namely, Langley Park and Ushaw Moor—by electricity, and Quebec with improved oil lamps.

Mile End (London).—Notice has been given by the County of London and Brush Provincial Electric Lighting Company, Limited, of their intention to apply for a provisional order to light Mile End Old Town.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending Aug. 2 amounted to £1,357, as compared with £1,355 in the corresponding week of the previous year, being an increase of £2.

National Telephone Company.—The Right Hon. Sir James Fergusson, M P., has been elected a director of the National Telephone Company, Limited, to fill the vacancy caused by the death of Sir Henry George Calcraft.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ending July 31 were £2,376. 11s. 6d., compared with £1,985. 14s. 10d. for the corresponding period of last year, being an increase of £390. 16s. 8d.

Mosses and Mitchell.—Messrs. Mosses and Mitchell, of Chiswell-street, E.C., announce that Mr. C. Barry Hayes and Mr. John Wood, who for many years have taken a leading part in the management, have now become partners in the firm.

Competition—A competition has been announced for schemes for electric lighting and power transmission for the new prisons at Fresnes-les-Rungis. The competition takes place at the Hotel de Ville, Paris, and schemes must be in by October 1.

Brazil.—According to telegrams from Rio de Janeiro the contract for furnishing the plant for the electric lighting of Carangola, State of Rio de Janeiro, has been placed in Europe, but neither the name of the firm or its nationality is given.

Electric Light Fittings and Fire.—The Liverpool and London and Globe Insurance Company are issuing a pamphlet embodying electrical installation rules, with a view to avoiding the risks of fire which attach to ignorantly or carelessly applied fittings.

D P. Battery Company, Limited.—At the general meeting of the D.P. Battery Company a dividend of 19 per cent. has been declared for the past year. It has been determined, in view of the profits that have resulted, to lower the price of the battery.

Portsmouth.—The Electric Lighting Committee have instructed their engineer to get out specifications for additional electrical plant. The order for the vertical engine will be placed with Messrs. Yates and Thom, and Ferranti's alternators will be used.

Metal Manufacturers' Association.—At a meeting of the committee of the Metal Manufacturers' Association it has been decided to advance the prices of rolled brass and copper, brazed brass tubes, and brass and copper wire ½d. per pound, from August 1.

City and South London Railway.—The returns for the week ended August 2 were £1,036, compared with £804 for the corresponding period of last year, being an increase of £232 The total receipts for the half-year 1896 were £4,524, compared with £4,224 last year, being an increase of £300.

Golf.—The *Nottingham Daily Guardian* says Henley's Telegraph Works Company are promoting a golf tournament which should certainly prove attractive to the professionals, as the prize money is to amount to no less than £150, the only restriction being that the competitors should use one of the Henley Company's golf balls.

Southborough.—The Urban District Council have received a notice from the Guildford Electricity Supply Company, Limited, of their intention to apply in December next to the Board of Trade for a provisional order to supply the district with electricity for any public or private purpose. The Council will probably oppose the application.

British Light Railway Development Syndicate.—Under the title of the British Light Railway Development Syndicate, Limited, a company has been registered by W. T. J. Hooper, 23, Bucklersbury, E.C, with a capital of £10,000 in £1 shares, to prospect in Great Britain and Ireland for suitable localities for the construction of light railways, tramways, etc.

London Light Railways Construction Company.—Under the title of the London Light Railways Construction Company, Limited, a company has been incorporated to enter into contracts for the construction, repair, and maintenance of any works whatever, including railways and other roads or ways to be used for traction by electricity, steam, or other agency, also telegraphs, etc.

Pretoria (Transvaal).—The tramway company has obtained permission from the Government of the South African Republic to substitute electric for horse power, provided the townspeople express themselves in sympathy with the proposed change. The plant has already been ordered from England, and work is expected to be commenced early next month. The cost of construction is estimated at something like £8,500 per mile.

Northwich.—The clerk has reported to the Rural District Council that the secretary of the Northwich Electric Supply Company had asked the consent of the authority to the application for a provisional order which it was the intention of the company to make. The Council have already given their consent to the scheme. It was resolved to assent to the application of the company, subject to reasonable precautions.

Improved Incandescent Lamp Syndicate.—Under the name of Improved Incandescent Electric Lamp Syndicate, Limited, a com-

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pany has been registered by C. W. and H. B. Taylor, 31, Crutched-friars, E.C., with a capital of £700 in £1 shares, in order to enter into an agreement with S. P. Eastwick and E. Sayer, and to carry on the business of electricians and electrical engineers in all its branches. The registered office is 130, Fleet-street, E.C.

Burnley. — At a meeting of the Electric Lighting Sub-Committee, on Thursday week, the electrical engineer was instructed to make enquiries in Yorkshire-street with a view of extending the electrical mains in that district, an application having been received from the authorities at a Catholic chapel for a supply of electric light. An extension of the main is also to be made in St. James-street, from Chancery-street to Calder street

Manchester —It was stated at the City Council that a further reduction had been made in the price of electricity to large consumers. The charge to such consumers had hitherto been 4s. per quarter per lamp and 2d. per unit of supply; it would now be 3s. per quarter per lamp and 1½d. per unit. That was equal to a reduction of 25 per cent, and it was hoped the result would be a great increase in consumption, particularly during the day hours.

Brockie-Pell Arc Lamp Company.—We are informed by Mr. B. Pell that the letters of allotment and regret in connection with the formation of the above Company were posted on Tuesday last, and the capital required was over-subscribed The Company, therefore, started on a financial basis as good as the lamp they are about to manufacture. All orders for the Brockie-Pell type of arc lamp should now be sent to the Company's offices, 14, Gracechurch-street.

Cardiff.—Mr. S. F. Walker has written another letter to the *Western Mail* criticising the design and management of the municipal electric lighting plant in connection with the recent breakdown. Practically, his letter comes to a suggestion that several small units should be worked instead of two large ones. The cause of the breakdown is known and has been published—it was not what Mr. Walker at first suspected—and a recurrence can, and probably will, be prevented in a much simpler way than Mr. Walker suggests.

Hampstead (London).—The Works Committee of the Board of Guardians have reported that they have received an estimate from the Exchange Telephone Company with regard to the workhouse being placed upon the telephone system and for communication being made between the workhouse and the medical officer's residence. The cost for the former was estimated at £25 per annum, with an additional cost of £9 per annum if an extension were made to the residence of the medical officer. It was decided to take no action in the matter.

Derby.—The Co operative Society have granted a lease to the Corporation for seven years at £1 per annum of a cellar in the basement of their premises at the corner of Normanton-road and Ambrose-street, for the purpose of fixing therein the transformer which now stands at the corner of the streets opposite their premises. The arc lamp-posts have been painted at a cost of £25. The Local Government Board have sanctioned the borrowing of £11,134 for electric lighting purposes. Sowter's road has been lighted with incandescent electric lights, and the cost per lamp ascertained to be £4. 12s 9d. per annum.

Glasgow.—The Corporation Tramway Committee met recently and considered the report of a sub-committee on the overhead system of electric traction. By the casting vote of Mr. Walter Paton, the convener, it was agreed to approve of the sub-committee's suggestion to adopt the system on the detached route from Springburn to Mitchell street, a distance of about 2½ miles, double track. The estimated cost for a three minutes' service is as follows: Overhead construction and rail bonding, £3,300; power-house, £2,000; generating plant, £6,000; feeders, £2 200; 15 new motorcars at £550 each, £8,250, less cost of 15 ordinary cars required and hereby superseded at £145, £2,175—£6,075 Total, £19 575.

Appointments Vacant.—In consequence of Mr. Rhodes's appointment at Salford, there is a vacancy at the City and Guilds Central Technical College for an assistant with a good knowledge of mathematical and experimental physics. The salary commences at £150 per annum, and application should be made in the first instance by letter to Prof. Ayrton, Central Technical College, Exhibition-road, London, S.W.—The Leeds Corporation want a clerk of the works for the electric tramway. Applications, stating experience and salary required, should be sent to the Town Clerk. The Corporation of Bristol want a charge engineer at £2 a week. Application is to be made to Mr. Faraday Proctor, city electrical engineer, Temple Back, Bristol.

Liverpool.—At a meeting of the Lighting Committee a letter was read from Sir Arthur Forwood, M.P., the chairman, resigning his position as chairman on the ground that he will be unable to give the increased time and attention to the duties necessitated by the handing over of the Electric Supply Company's undertaking to the Corporation. Mr. Petrie was then appointed chairman, the position of deputy-chairman being awarded to Mr. J. S. Harmood Banner. The committee resolved to instruct Mr. A. B Holmes, electrical engineer, to carry on the manufacture, sale, and arrangement of fittings as heretofore, but directed that if an application was received to place fittings outside the area of the city or port of Liverpool or the borough of Bootle that matter must be brought before the committee.

Fort William (Inverness).—The works in connection with the Fort William Electric Lighting Company, Limited, are nearing completion. So far advanced is everything that on Saturday and Sunday the light was turned on in the accumulator-house. The street cables have been laid and the overhead wires are all but completed. It is anticipated that all the churches, hotels, and private houses which have already been wired will be connected within the next fortnight. The Station Hotel is to be illuminated throughout from the company's works. It is understood the hotel is fitted with about 350 lights. As if to encourage the electric light the Fort William gas supply failed on Sunday night, and, as has been done on similar occasions, candles and paraffin lamps had to be resorted to by the inhabitants.

Gateshead.—The Parliamentary Committee have reported as to the desirability of the Corporation making application to the Board of Trade for a provisional order empowering the Council to supply electricity in Gateshead, as, in the opinion of the committee, any system of electricity in the borough should be in the hands of the Corporation instead of a private company. The Newcastle and District Electric Lighting Company, Limited, had recently intimated that they had abandoned the idea of obtaining a provisional order for the supply of the electric light in Gateshead, and as no notice had been received from any other company, no application could now be made to the Board of Trade for a provisional order except by the Corporation. Under such circumstances they recommended that for the present no action should be taken by the Council to obtain the necessary order. Alderman Lucas said the committee had been engaged for some time in gaining the fullest information on the question of electric supply. The committee had by no means abandoned the undertaking, and, whilst anxious to keep the supply in their own hands, were in no hurry so long as there was no immediate chance of any rapid development. The report was adopted

Islington (London).—The report of the Electric Lighting Committee, which comes before the Vestry to-day (Friday), states that with reference to the action in the Clerkenwell County Court by Mr. A. T. Young, cab proprietor, for damage to a hansom cab alleged to have been caused by its coming into collision with street refuge in the Upper-street after the electric light on the refuge had been turned out, the vestry clerk reported that notwithstanding the summing up of the judge to the effect that there was no evidence to show that the Vestry had improperly exercised the discretion vested in it by Section 130 of the Metropolis Management Act, 1855, the jury had found a verdict for the plaintiff (the damages, if the Vestry were liable, having previously been agreed at £30), but that the judge had, upon the application of the Vestry's solicitor, caused judgment to be entered for the Vestry on the grounds above stated. The solicitor for the plaintiff had since given notice of appeal, and the Vestry's solicitor had been instructed to take all steps necessary to support the judgment. It was further added that in the early morning of the 24th ult. (the judgment above referred to having been given on the 23rd ult) two hansom cabs were reported by the police as having come into collision with the same refuge when the light was turned out, and that a claim had been made in one case by the owner for compensation. Having regard to the judgment in the previous case, the committee instructed the vestry clerk to write repudiating any liability.

Electrical Development and Finance Corporation, Limited. Under this title a new company has been formed, with a capital of £500,000, in £1 shares, of which 250 000 are now offered for subscription. The prospectus states that the Corporation has for its primary object the promotion and development of undertakings for utilising electrical power in all its industrial applications, and its business will not be confined to the British Isles, but it is proposed to be extended to the Colonies and foreign countries. The directors attach importance to the field for enterprise presented by the transmission of electric power for mining and other purposes from existing water powers, and by electric traction for tramways. The latter subject is now receiving serious attention from tramway companies, engineers and capitalists, and the Corporation anticipates a considerable revenue from the promotion and development of electric tramway undertakings. It is added that the Corporation intends commencing operations at once, and has under consideration the exploitation of a new and improved system of electric traction, the electric lighting of an important and rapidly-growing district, an interest in a new and thoroughly practical self-starting alternating current motor, and the construction of a system of electric generating stations and the transmission of power in a mining district of South Africa. The Board consists of the Duke of Newcastle, Mr. W. Crookes, F.R S (Notting Hill Company), and Mr W. C Johnson (Johnson and Phillips, Old Charlton), and Mr. Medhurst is the consulting engineer. The subscription list closes to-day (Friday) for London and to-morrow for the country. The temporary offices of the Company are at 24, Coleman-street, E.C.

Kingston-on-Thames.—The electrical engineer has reported to the Lighting Committee that the first electric launch was charged on June 8 The Thames Conservancy have agreed to piles being fixed where the launches are to be charged. The committee has assented to the conditions imposed by the Surbiton District Council for the supply of current from the Corporation works to the assembly rooms, subject to a satisfactory agreement being submitted. The draft agreement with the Maldens and Coombe District Council respecting the supply of electricity in their district was approved, subject to modifications, and the Council was recommended to authorise the affixing of the seal to the agreement—the effect being that the Corporation would have the right, subject to the approval of the Local Government Board and the Board of Trade, to supply electricity in Coombe, and, if subsequently agreed, in New Malden and Old Malden, and that an application would be made to the Board of Trade for authority to extend the electric main to such district. Councillor Kitching asked what was the cost of the 1,300 yards of cable necessary to convey the current from

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Kingston-hill Post Office to a house half-way up Liverpool-road, and what return was expected from the house where the light had been put in. Councillor Collings said the cable was taken to Liverpool road because they were compelled to take it there, having obtained the approval of the Local Government Board to the loan on condition that they would put a main there when requested. As soon as a customer came and asked for it, being within the compulsory area, they were obliged to do it. The cable cost about £240, and the revenue from the house would be about £34 a year, but of course other houses would come on to the same cable. The report was subsequently approved.

Coventry.—In moving in the Town Council that the Electric Light Committee should be instructed to prepare and submit a scheme and an estimate of the cost of electric lighting for Hertford-street, Broadgate, Crosscheaping, Burges, Bishop-street, Smithford-street, High-street, and Earl-street, Mr. West said his motion simply asked the Council to become customers to their own undertaking. Mr. West then proceeded to read the opinion of Mr. Hammond, their consulting electrical engineer, to the effect that the benefits to the electricity works itself of a public lighting business are now becoming generally recognised. One of the greatest advantages which accrued to works dealing with public lighting was the material assistance given to the lowering of the cost of production by the long hours of burning of the street lamps. Street-lighting was an advertisement for the undertaking. According to the latest statistics it was considered that from 1½d. to 2d. per unit was sufficient to cover the cost of public lighting supply. Mr. West estimated the total cost for gas in these streets to be dealt with at £217. 11s. 9d., while Mr. Ram, the Council's electrical engineer, estimated that in these streets could be put up 22 800 c.p. lamps at the cost of £18 each per annum, and these would light the streets well. This would include half the lamps burning from 12 o'clock midnight until daylight, and would average 3,000 hours per year for each lamp. The 22 electric arc lamps of 800 c.p. at £18 each per annum would make a total cost of £396. These 22 lamps would equal 17,600 c.p., as against the present illuminating power of the gas lamps of 1 885 c p. If the price he had named was accepted by the committee it would compare with gas thus: gas, 100-c.p. lamps, £9 each; electricity, 800 c.p. lamps, £18 each. He would simply leave the matter upon its merits, and ask the Council to send the motion to the committee for further investigation. Mr. Goate seconded. Alderman Tomson, as a member of the Electric Light Committee, said he could not support the proposition. In the first place it was not at all clear that the arc light would be suitable for such narrow streets. Ultimately the resolution was lost by five to ten votes.

Bolton.—The electric lighting extensions of Messrs. Tootal, Broadhurst, and Lees's Daubhill Mills is to be done by Messrs. Drake and Gorham. Mr. W. Druce, Manchester, is the consulting engineer. The proceedings of the Joint Sub-Committee on electric traction have been confirmed at a meeting of the Streets Committee. It appears that the tramway lessees are not prepared to comply with the Corporation's proposals as to electric traction. The town clerk has been requested to advise as to the proceedings to be taken by the Corporation for carrying into effect the proviso contained in the tramways lease for the adoption of mechanical traction, and it was resolved that a communication be made to the Urban District Councils of Astley Bridge, Farnworth, and Kersley inviting a conference upon the adoption of electric traction on the Bolton and suburban tramways generally. The Gas and Electricity Committee have deferred consideration of the application of Messrs. Gillibrand and Hodgkinson for the supply of electricity to their premises in Bridgeman-place. The question of making alterations to the steam separators in the engine-room at the electricity works was referred to the chairman and engineer. The attention of the Manchester Edison-Swan Company, Limited, was ordered to be again called to the slow progress made in the carrying out of their contract for additions to the switchboard. A resolution of the Streets Plans Sub-Committee was read making application that the electrical engineer be allowed to make an examination and report upon an electric installation to the new premises of the Great and Little Bolton Co-operative Society, Bridge street, as required by the Board of Trade, and it was resolved that the electrical engineer examine and report. The engineer submitted a statement of further capital expenditure required for the purposes of the electricity department, and it was resolved that application be made to the Local Government Board for sanction to borrow money to the amount of £35,000 for electrical purposes. It was decided that the charge for superintending electric fitting works required by consumers be 5 per cent on the cost of such work, and that the resolution adopted by the committee on June 26 be altered accordingly. The Town Council passed the reports.

Bedford.—The committee have reported to the Bedfordshire County Council as to installing the electric light in the shire hall and county offices. The report as presented a year ago was read, showing that the estimate for lighting the hall, offices, lavatories, etc., was £79, and the rest of the building £145. 16s. The surveyor now reported that in accordance with instructions he had asked for prices from four firms for lighting only at present the portions requiring nightwork—viz, the offices of the clerk of the peace and county surveyor and the main entrance and corridors approaching thereto. The contractors had also been requested to include in the price a sufficiently large main supply to eventually complete the whole building, if so desired, or any section of the building, as from time to time might be determined upon. Messrs. Laing, Wharton, and Down, of 82A, New Bond street, London, offered to lay in a supply main to the distributing board for 250 16-c p. lights and wires, the corridors and offices of the clerk of the peace, also the county surveyor's offices, and prepare same for the fittings (which were not included) for £34. 15s. Messrs. Ellis and Ward, of Birmingham, agents to the Brush Electrical Engineering Company, Limited, quoted upon a very limited specification, saying they had included sufficient mains for this lighting only, with a slight margin for one or two extra lamps. It, however, would be possible to extend this lighting all over the building by the addition of heavier cables as required. Their price for 19 lights was £25, and the probable cost for the larger service to the distributing board might be estimated at about £5 more. Mr. Henry Bacchus, of Bedford, had submitted the following estimate: The cost of electric lighting installation at shire hall for 22 lights complete, with main wires sufficient to carry same, would be £32. If extra large main wires sufficient to carry an additional 100 lights for future extension, £5 extra. This price was complete with two distribution boxes. All office lights to have counterweights for raising and lowering. Messrs. Kilpin and Billson, of Bedford, had tendered upon a very clear and sufficient basis of a main supply for the whole building as far as the distributing board, from which point the present suggested partial lighting should be served, and any other part or whole later on. Their price for the suggested installation of 20 lights and larger cables was £29. 10s. Mr. Leeds-Smith said electric lighting appeared to be in its infancy; £30 was now the estimated cost for what a year ago was £80, so he was encouraged to think that if the matter were left another year the cost would grow considerably less. He therefore moved that the matter stand over. The Clerk pointed out that the estimate was less now than before because the area proposed to be lighted had been much reduced. Mr. Whitworth remarked that the courts and most of the rooms in the shire hall were used only occasionally at night, so it was immaterial whether they were lighted by gas or electricity. Ultimately, Mr. Cole said he never knew anyone who adopted the electric light go back to gas, and he moved that the matter be referred to a sub-committee to decide which firm the work should be entrusted to. This was agreed to.

Belfast.—The committee have reported to the Town Council that they have had under consideration the probable necessity of increasing the present gas-driven plant in their central station, as that now available will in all likelihood be fully utilised before the extension of the system proposed can be taken in hand. The committee add that it is satisfactory to know that the engineer's report shows a fair surplus over the working expenses. Councillor Andrews, in moving the adoption of the report, said the committee had not yet arrived at any definite conclusion as to the amount of plant that would be at present required, but they roughly estimated it as equivalent to about 7,000 more lamps, bringing up the possibility of wiring to 20 000 lamps. At the present time their safe limit was almost fully occupied. They had about a free margin of 1,000 8-c.p. lamps. Therefore it was absolutely necessary for the committee to take this matter of increased generating power in hand within a short time. The makers of the last engines, which had been going fairly satisfactorily, said they now saw where the difficulty existed, and that they could overcome it and deliver an engine, or a couple of engines, within a very short time. The difficulty would be in getting dynamos, the makers being so busy at the present time preparing for the coming winter season. The committee would probably report to the Corporation next month that they had entered into negotiations for the erection of further plant, so that consumers need not be anxious about being short of supply in the winter. It was rather early yet to bring forward the larger scheme, which had been reported to the Council. The outlay would be so large that it would have to be included in the report of the Finance Committee for next year. It would amount, he might say roughly, to about £100,000, and that would give them a supply sufficient to enable fully six times the present number of lamps being wired. Councillor Herdman seconded the report. Councillor Woodside enquired whether gas-engines were most economical. He also wished to know whether the makers of the engines were responsible for the cost of altering them where they did not work satisfactorily. Councillor Young said that if it went forth that the Electric Committee were making a large profit, the ratepayers would think they were being charged too much for the electric light. It was misleading to say there was a fair surplus, because really there was no surplus at all. They had borrowed £30,000, and the interest on that was not provided for, nor was there anything for a sinking fund. He protested against any increase of the driving power at the present central station. The sooner they got out of the present station and on the banks of the Lagan the better. Councillor Barklie said the present station was not initiated by the members of the Electric Committee but by the Gas Committee. He had no doubt that when they got steam they would be able to supply electricity at a cheaper rate. Councillor Andrews said they were at present paying nearly three times as much for their fuel as they would with a steam-driven engine. With regard to the last two engines, the makers were bearing all the expense of making them efficient. With the high cost of fuel they could not possibly make any show in the way of earning a profit, but if electric lighting went on as it had been going on in Belfast there was no doubt they would be able in time to show a surplus at least sufficient to pay interest. The report was then adopted. The report of the Belfast Street Tramways Company states that the directors regret that up to the present they have not been able to come to terms with the Corporation for the working of the Belfast tramways by electric traction. In the meantime the company's Bill authorising the use of electric traction

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has been passed, but subject to the sanction of the Corporation being first obtained. The whole matter now, therefore, rests with the Corporation.

PROVISIONAL PATENTS, 1896.

JULY 27.

16551. Commutator protector. Allan Burgess Roxburgh and Thomas Dowler Green, 30, Goldsmith-road, King's Heath, Birmingham.

16566. Improvements in or relating to electric bells or signals. John Rendell, 16, Long-street, Devizes.

16592. Connecting plug for telephone cords. Burton Hawke and the London Electric Wire Company, Limited, Playhouse yard, Golden-lane, London.

16597. Improvements in and relating to primary batteries. René Marie Joseph Heurtey and Pierre Germain, 111, Hatton-garden, London.

16602. An improved protective device for the dispersing lenses of light projectors. Henry Harris Lake 45, Southampton-buildings, Chancery-lane, London. (Elektricitäts-Actiengesellschaft vormals Schuckert und Co., Germany.) (Complete specification.)

16608. An improvement relating to magnetic compasses. Joseph Daniel Rowbotham Blain, 166, Fleet-street, London.

16629. Improvements in the construction of electric cables. Joseph Daniel Rowbotham Blain and William John Pawson, 166, Fleet-street, London.

JULY 28

16644. Improvements in the means of attaching metal contacts in electrically-controlled and other gas burners. Frederic Richard Boardman, 238, Tottenham Court-road, London.

16657. Improvements in means or apparatus for the measurement of electric energy. Georg August Julius Telge, 55, Chancery-lane, London.

16683. Improvements in alternating electric current transformers. John Alexander McMullen, 124, Chancery-lane, London.

16726. Improvements in electrodes for secondary batteries Friedrich Wilhelm Schneider, 18, Buckingham-street, Strand, London. (Complete specification.)

16729. Improvements in the manufacture of caustic soda and other alkaline hydrates and compounds by electrolysis. Leonard George Attenborough and Evan Aspray Sulman, 111, Hatton-garden, London.

16737. Improved apparatus for generating or collecting electric energy. Joseph Daniel Rowbotham Blain, 166, Fleet-street, London

JULY 29.

16790. Telegraph-wire reel. Heinrich Ehricht, 10, Friedrichstrasse, Berlin. (Complete specification.)

16801. Improvements in electrical cut-outs. Armand Farkas, 2, Lancaster-place, Strand, London.

16852. Improvements in electrolysis. Gradon Poore, 70, Chancery-lane, London (Complete specification.)

JULY 30

16894. Improvements in and relating to instruments for measuring electric currents. James Finlayson, 62, St. Vincent-street, Glasgow.

16916. Apparatus for obtaining oxygen and hydrogen from steam by electrolysis. Edmond Strzelecky, 28, Southampton buildings, Chancery-lane, London.

JULY 31.

17001. Electrolytic manufacturing of cyanide of alkali. Robert Pauli, Oldbury. near Birmingham.

17025. Improvements in incandescence electric lamps. Thomas Archer Rose and Rose and Bird, Limited, 55, Chancery-lane, London.

17044. Improvements in and connected with apparatus for lighting and extinguishing gas jets by means of an electric current. William Edwards, 11, Furnival-street, Holborn, London.

AUGUST 1.

17088. Improvements in electric batteries. Henry William Headland, 77, Chancery-lane, London

17093. Improvements in counterbalance weights for electroliers, gasoliers, and other suspended fittings. George Montague Sellick, 70, Chancery-lane, London.

17098. An automatic electrical switch or exchange. Andrew Sautter and John J. Sautter, 104, Peckham-road, London.

17101. Improved electrical switch. James Hermann Field, 28 Southampton-buildings, Chancery-lane, London.

17103. Improvements in or applicable to phonographs. The Edison-Bell Phonograph Corporation, Limited, and Augustus Stroh, 191, Fleet-street, London.

17122. Improvements in metallic junction-boxes and means for uniting metal conduit-tubes thereto and to each other. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Edwin Truman Greenfield, United States.) (Complete specification.)

17123. Improvements in insulating joints for metal or armoured conduct-tubes, more especially suitable for electrical conductors. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Edwin Truman Greenfield United States (Complete specification.)

17124. Improvements in and connected with conduits, more especially suitable for electrical conductors. Henry Harris Lake 45 Southampton-buildings, Chancery-lane, London. (Edwin Truman Greenfield United States.) (Complete specification.)

17125. Improvements in conduit-tubes, more especially suitable for electrical conductors. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Edwin Truman Greenfield United States.) Complete specification.

SPECIFICATIONS PUBLISHED.

1895.

13113. Telephonic installations. Lake. (Baivy.)

13175. Telephone exchange switchboards. Stock.

16897. Holders and supports for electrical candles Hirst and Gibson.

17782. Electric contact for use with clocks and the like. Wall.

18870. Electromotors and transformers. Langdon-Davies and the Alternate-Current Electromotor Syndicate, Limited.

1896.

4617. Electric railways. Coerper.

6437. Current collectors for electrically-actuated tramway vehicles on the conduit system. Lake. (Union Elektricitäts Gesellschaft.)

9171. Electric railways on the conduit system. Fairweather. (Munson, Roberts, Alston, Reid, and Reid.)

10047. System of and means for electrical transportation. Stern.

10772. Starting and stopping devices for electrically-operated elevators. Otis Elevator Company, Limited. (Otis Bros. and Co.)

12650. Thermo-electric generators. Cox and the Cox and Thermo-Electric Company.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5¾-6¼
Brush Company, Ordinary	3	1-1¼
—— Non. Cum., 6 per cent. Pref.	2	1¼-1½
—— 4½ per cent. Debenture Stock	100	112 116
Charing Cross and Strand	5	8¼ 8¾
Chelsea Electricity Company	5	7¾-8¼
—— 4½ per cent. Debentures	100	114-116
City of London, Ordinary	10	15-16
—— 6 per cent. Cumulative Pref.	10	16½-17½
—— 5 per cent. Debenture Stock	100	133 137
City and South London Railway, Consolidated Ordinary	100	45-47 xd
—— 4 per cent. Debenture Stock	100	136 138
—— 5 per cent. Pref. Shares	10	14½-15 xd
County of London and Brush Provincial Co., Ordinary	10	8-9
—— 6 per cent. Cum. Pref.	10	13½ 14
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
Edison and Swan United Ordinary	3	1¾-2¼
—— 4½ per cent. Debentures	100	103-106
Electric Construction, Limited	2	1¼-1¾
—— 7 per cent. Cumulative Pref.	2	2¾ 3
Elmore's Copper Depositing	2	[illegible]
Elmore's Wire Company	2	[illegible]
W. T. Henley's Telegraph Works, Ordinary	10	17½-18½
—— 7 per cent. Preference	10	17½-18½
—— 4½ per cent. Debentures	100	109-114
House-to-House Company, Ordinary	5	4 4½
—— 7 per cent. Preference	5	8-8½
India Rubber and Gutta Percha Works	10	22-23
—— 4½ per cent. Debentures	100	106-109
Isle of Man Electric Trams, Ordinary	1	1¼-1¾
—— 6 per cent. Preference	1	1¼-1½
Kensington and Knightsbridge Ordinary	5	9½-10
—— 6 per cent. Pref.	5	7¾ 8¼
Liverpool Electric Supply, Ordinary	5	8-8½
Liverpool Overhead Railway	10	13¼-13¾
—— 5 per cent. Pref.	10	17¼-17¾
—— 4 per cent. Mortgage Debentures of £100	100	112½-114½ xd
London Electric Supply	5	¾-1¼
Metropolitan Electric Supply	10	13¼-13¾
—— 4½ per cent. First Mortgage Debenture Stock	100	119-123
National Telephone, Ordinary	5	7¾ 8
—— 6 per cent. Cum. First Pref.	10	17-19
—— 6 per cent. Cum. Second Pref.	10	17-18
—— 5 per cent. Non. Cum. Third Pref.	5	6¾-7¼
—— 3½ per cent. Deb. Stock	100	107-110
Notting Hill Company	10	11-12
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8¼-8¾
—— £4½ shares	4½	7¼-7¾
Oriental Telephone and Electric Company	1	¾-⅞
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	105-107
Southampton Electric Company	5	4¾-5¼
St. James's and Pall Mall, Ordinary	5	12½-13½ xd
—— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	39-42
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary		8-8½
Westminster Electric Supply, Ordinary	5	11-12
Yorkshire House-to-House	5	7¼-7¾

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NOTES.

The Electric Railway.—There was some kind of a breakdown on Thursday week on the City and South London Railway, but whatever was the matter was soon put right and traffic resumed.

Tennessee Exhibition.—There is to be a centennial exhibition at Nashville, Tennessee, next summer. The United States Government have nothing to do with it, though they give facilities so far as the Custom House is concerned, but the State authorities hope for foreign exhibits on a considerable scale.

Electric Locomotive.—The Westinghouse electric locomotive, which is to be examined by the officers of the New York elevated railways with a view to having trials made, has been described by the *Engineering News* as resembling "a street car mounted on four-wheel trucks." Each truck (bogie) has two Tesla polyphase motors.

Street Box Explosion.—An explosion took place in the electric light surface box at the corner of Vere-street and Oxford-street about half-past nine on Wednesday evening, which was probably due to a leakage of gas into the box. No one was hurt, but the pavement was thrown over, and, of course, a large crowd was attracted by the noise.

Motorcarts.—The Lords have agreed to the Commons' amendments on the Locomotives of Highways Bill, which therefore only awaits the formality of the Royal assent. A financial contemporary in noting the fact speaks of the measure as the "Auto-Motor Car Bill," which seems a distinctly pleasing deviation into absurdity in the way of nomenclature.

American Tramcar Accident.—At Columbia, in Pennsylvania, last Sunday, a tramcar ran away downhill, jumped the rails at a curve, capsized into a ditch, and killed five of its occupants. Already this accident has been put down to the fault of electric traction, instead, of course, of being ascribed to its true cause—namely, want of effective brakes.

Light Railways Association.—Although the work of this association has been done so far as promoting legislation is concerned, it has been decided to continue its existence, "as one means, in co-operation with other organisations, of carrying out the powers in the Bill by affording information and assistance and facilitating the construction of light railways."

Associated Chambers of Commerce.—At the meeting to be held at Southampton next month resolutions will be submitted urging the necessity of improving the trunk line telephone communications, and the advisability of the compulsory adoption of the metric system, and also calling attention to the slow progress made in relation to direct cable communication with the Colonies.

The Telephone Girl.—The Telephone Girl Company, Limited, has been registered, and that, too, by a firm in Victoria-street. Nevertheless, its object is not to furnish the National Telephone Company with an article that shall better meet the wants and wishes of its customers than anything that company has hitherto been able to supply. In fact, the new company is a purely musical and dramatic affair. There is a company which proposes to do away with the telephone girl altogether—but that is another story, and is therefore told elsewhere.

The Metric System.—It has been stated by people that ought to know that it is at present actually illegal to possess a weight or measure on the metric system. In the piecemeal way in which legislation is effected in this country it is quite possible that this may have been brought about without anybody knowing it. If so, it is appalling to think of the august institutions that have been encouraging this illegality. Most people, including the writers of some text-books, thought the metric system was legalised years ago by 27 and 28 Vict., cap 117.

Death of Captain M'Callum.—The British Consul at Beira has received and forwarded on a despatch from Major Forbes received by a runner from Chinde stating that Captain M'Callum, the constructor of the African trans-continental telegraphs, was murdered by Mashonas at Matetimi on June 25. The attack was entirely unprovoked, and loot was the only excuse. Major Forbes did not anticipate any check to the work beyond the bad effect on the "boys"—*i.e.*, the native workmen—but at the time of writing the despatch he was evidently unaware of the state of the country and the Mashona revolt.

Ushant Lights.—It is stated that an exchange of communications has taken place between the British and French Governments on the subject of an exhaustive survey off Ushant and the neighbourhood. The survey is to extend to at least 10 miles out, and two or more lighthouses telegraphically connected with the shore may be constructed. Considering that the loss of the "Drummond Castle" was in no way due to any fault of the French lighthouse service or to inaccurate charting of the coast, but to quite other causes, the readiness and goodwill displayed by the French authorities is most commendable.

Telegraph Troubles.—Some boys were had up before the magistrates at Ipswich the other day, and fined for smashing telegraph insulators. Incidentally, the district engineer of the Post Office Telegraph Department stated that no less than 56 insulators had been destroyed, and great inconvenience had been caused by it. The rest of Suffolk has always refused to be responsible for the sins of Ipswich, which is in it but not of it. But those Ipswich boys must be terribly good shots with a stone for 13 insulators in the day, and an aggregate of 56 must be something near the "record" score in insulator smashing.

A Modern Icarus.—We are sorry to hear that Mr. Lilienthal has met his death while in pursuit of his experiments in the art of learning to fly. He despised the assistance of motors, and using wings only was able to manage long swoops of 200 or 300 yards, but was not much good at rising. This week, however, when on one of his flights at Colenberg, in Prussia, a gust of wind toppled him upside down, and he was dashed violently to the ground and killed. The path of the contriver of flying machines is a dangerous one. The original, and by all accounts most successful inventor of them all, seems to have given it up after he had lost his son—and, what is worse, no one has ever been able to find his working drawings.

Water-Jets as Conductors.—Some time ago we noted that some American firemen received electric shocks which they believed were communicated through the jet from a fire-engine hose. Considering what a particularly good earth a fire-engine must have in its suction pipe it seemed unlikely, but it appears that so far as alternating currents are concerned the matter has been already determined experimentally by Prof. Slaby, of Berlin. The overhead conductors of a 10,000-volt power transmission line were used for the experiment. A voltmeter was connected between the metal mouthpiece of the water-hose and the earth. On turning the water on to the live conductors no flow of current to earth was noticeable.

Our Chinese Visitor.—According to the arrangements made for him to-day (Friday), Li Hung-Chang is to go to Greenwich to visit the cable factory of the Telegraph Construction and Maintenance Company, at Enderby's Wharf.

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There is, of course, to be a dinner, or whatever is the proper name for it, and it is understood that the Eastern Telegraph Company is to do some things in the way of telegraphy to distant parts of the world which have not been done before—even in America. But whether his Excellency Li Hung-Chang will have anything particular to say to his friends in Pekin, and whether those friends, instead of going to bed at the usual Chinese time, will sit up and make a night of it, in order to answer him, remains to be seen.

Police Calls.—In reference to the letters to the *Times* which we briefly commented on last week, the secretary of the District Messenger Company says that a policeman was not sent to Mr. Norman, as one could not be found at the usual points. As Mr. Norman himself complains that there are not enough policeman in Grosvenor-road to meet the requirements of that neighbourhood, this sounds plausible. Moreover, there was a successful burglar-hunt going on at the time, which would naturally occupy their attention. Mr. Macdona did not get his policeman because his signal was indistinct. The company do not appear to have arranged to "stock" either policemen or fire-engines, but with regard to the latter "they have made proposals to the Fire Committee of the London County Council."

Mining Engineers.—The students connected with the Federated Institution of Mining Engineers, after their second annual conference in Leeds last week, paid a visit to Micklefield for the purpose of inspecting the scene of the recent explosion. Messrs. Cliff and Sons, the owners of the Peckfield Pit, gave the students every facility for viewing their property, the manager, Mr. C. Houfton, and Messrs. Hargraves and Holliday, who are also connected with the firm, conducting the party underground, where a thorough inspection of the various appliances and machinery was made. The party having returned to Leeds had an opportunity of inspecting the Yorkshire College and the central electric lighting station of the Yorkshire House-to-House Electricity Company, Limited. The next day there was a visit to the Ackton Hall Collieries, Featherstone.

The Pacific Cable.—In the House of Commons on Tuesday night, on the Colonial votes coming up, Sir Charles Dilke expressed the hope that the Government would do their best to develop cable communication with Australasia *viâ* Gibraltar, Sierra Leone, and the Cape, and urging that this route had strategic advantages which the Canadian Pacific route would not possess. Mr. Chamberlain, without discussing the question of strategic advantages, observed that both Canada and Australia would give good subsidies towards a Canadian Pacific cable. That, of course, is a good reason, but the Colonial Secretary, if he had chosen, could easily have defended the Pacific route on its merits. In case of war the only safe thing for an enemy's ship in the Pacific to do would be to get into a neutral port as quickly as possible and stay there. There is only one European Power that could be really troublesome in a maritime war, but owing to our practical abandonment of East Africa that Power would have the Sierra Leone sections of the other route very much at its mercy.

American Patents.—The growth of the patent system in the United States of America is clearly set forth in the fiftieth anniversary number of the *Scientific American*. Up to the end of 1845 only 3,873 patents had been granted, and the number issued that year was only 503. Now the total number has risen to the grand total of 531,619, and the number issued in 1895 was 22,057. In the classified list of total patents we are pleased to see that electrical inventions take the third place with 18,052 patents, while the highest number is 20,821 for carriages and wagons. The most prolific inventor, or, more correctly, the man with the largest control over inventions, is Edison, who has no fewer than 711 patents under his name. Elihu Thomson comes next with 394, followed by F. Richards, E. Weston, C. Scribner, Depoele, and Westinghouse. The majority of these men have taken the greatest interest in electrical matters. The writer of the prize article on the above subject claims that the beneficial character of the American patent laws has done much to assist the country into its present position.

Chemical Society.—The last issue of the *Journal* contains some interesting matter. Mr. Masumi Chikashigé, of the Japanese Imperial University, contributes a short paper on the atomic weight of tellurium. This, as is well known, is not what it might be expected to be. Mr. Chikashigé determines it from Japanese tellurium at 127·6. The only importance of the matter is its bearing on the validity of Mendaleieff's law. Dr. Fitzgerald's Helmholtz memorial lecture is reprinted. A great deal of space is occupied by Dr. Kipping's researches on camphoric acid derivatives at the Central Technical College. To anyone not engaged in that particular branch of inorganic chemistry this paper is pretty stiff reading. There is a sort of supplement to it by Mr. W. J. Pope. Short notes in the abstracts show that Mr. E. A. Hill, in America, and Mr. R. M. Deeley do not believe argon and helium have monatomic molecules. Probably time will prove them right. At present there is a decided tendency to push the Maxwell theory of gases with a vigour which is hardly warranted by the "statistical" basis on which it rests.

Military Telephones.—Captain Charollois has communicated to the French Society of Civil Engineers some interesting experiments he has made in this direction. He has been investigating the distance at which conversation is possible if a bare wire is laid direct on the ground with earth return. In spite of the leakage to earth along such a line, he has found that speech can be transmitted perfectly over a line 15½ miles long. The ordinary call bells cannot, however, be used, and hence Captain Charollois has devised a magneto call to act on the diaphragm of the receiver. We consider the experiment most interesting as showing how bad a circuit must be before a telephone will refuse to act, but not as a guide to general practice in such work. We remember an instance some years ago in which a telephone erected as an attraction at a local flower show worked comparatively well although a portion of the circuit was completed through the canvas of a tent. The wire had broken, and the bare ends, held a few inches apart by the insulation, rested against the canvas of the tent inside which the telephone was working.

Salmon or Turbines.—We have already noted the attitude of the tourist on the subject of the utilisation of water power—he is generally the man who when he gets home writes to the papers suggesting general incompetence in the whole class of engineers because they do not make use of "the forces of Nature." Now, however, it is the fisherman who is giving trouble, and it is the salmon, not the landscape, that is sacrosanct. At the meeting of the Derwent Fishery Board Mr. Hall wanted a grating six or seven yards long and 4ft. high put up at the Keswick electrical works, for fear salmon might get into the watercourse and be chopped. The matter was left over to enable the clerk to look into the question of liability. The fisherman, however, seems much more reasonable than the tourist, and if he will be contented with a grating, no one will want to deny it to him. But, on the other hand, consideration for the convenience of the salmon has trebled the distance of the Fort William generating station from that town, and, moreover,

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compelled the company to do with a much smaller and less convenient water supply than would otherwise have been available.

Telephones in Japan.—According to the *Western Electrician*, at present there are several distinguished Japanese visitors in Chicago engaged in examining into the methods employed in electrical enterprises of various kinds there. Several of them have a Government commission to make a careful study of telephony. It is especially interesting, therefore, to note the announcement that engineers of the Department of Communications of the Imperial Government of Japan have received instructions to prepare estimates of cost for the surveying, designing, and installation of an extensive telephone system that will connect every portion of the islands with metallic service. The long-distance lines of the proposed system will altogether aggregate 25,000 miles in length, and the plan contemplates the establishing of 40 main offices and 180 public stations, which will be capable of handling 25,000 subscribers. At present telephone exchanges are in operation in Yokohama, Tokio, Osaka, and Kiobe, while next month an exchange will be in operation in Kioto. The system will embody both land and submarine construction, and the line construction will probably be begun next summer.

Institution of Electrical Engineers.—We have already acknowledged the receipt of the *Journal* of the Institute of Electrical Engineers, giving the last two papers of last winter's session. Mr. W. G. Rhodes's mathematical treatment of the subject of the iron loss in transformers as affected by the wave form is now available for criticism. Written in a condensed form on the blackboard, it was at the time of the discussion wholly lost on the majority of the audience. Messrs. Cowan and Still's paper before the Northern Society of Electrical Engineers, dealing with the regulation of pressure in alternating-current supply systems, is reprinted in full, and in the larger type as an "abstract." There is a falling off in the hitherto large percentage of Röntgen ray abstracts. Of these Prof. Goldhammer's (from *Wiedemann's Annalen*) and Mr. Zickler's deal with points of importance. There are several valuable abstracts from the *Beiblätter*. A description of Dr. Jacques's carbon-soda-iron battery is taken from an anonymous writer in *L'Eclairage Electrique*, which seems a roundabout way to get an account of an American invention. The abstract contains no information that has not been published in English in our Transatlantic contemporaries. At the end of the *Journal* the proceedings at the members' meeting of July 6 are given, and the receipts and expenditure and the balance-sheet for 1895 are appended.

Incandescent Lamp Tests.—Some tests of incandescent lamps were recently carried out at the New York Exposition by Messrs. Stone and Webster, comparing six lamps of the Edison type with six Imperial lamps. No particulars are given as to how the lamps were selected for the trial, but they were all rated by the respective makers to give 16 c.p. at 110 volts. This they did, and the average watts per candle for the Edison lamps at the start were 3·1, while the Imperial lamps took an average of 3·45 watts. After a 600-hour run only two Edison lamps and four of the Imperial type remained. The rest had burnt comparatively early in the run. The candle-power and efficiencies at the end of 600 hours' continuous burning are in favour of the Imperial lamps. These four lamps gave candle-powers varying from 14·5 c p. to up 15·6 c.p., with an average efficiency of 3·7 watts per candle. The two Edison lamps gave then 11·7 c.p. and 11·9 c.p. and took 3·75 watts per candle. We understand from our New York contemporary *Electricity* that these tests were the cause of some feeling between the two firms at the time. In such experiments the selection of the lamps can be made to have a most important influence; but, after all, it is tests on lamps as sold that the public require. It is specially worthy of note that of the dozen lamps here experimented with only seven survived a 200-hour run. This loss seriously depreciates the value of the lamp from a consumer's point of view.

Car-Wheel Grinding.—The fact that tramcar wheels frequently wear unequally has been often observed in this country. Hence the value of the apparatus for remedying this evil invented by Murphy, of Pittsburgh, will be appreciated. It is described and illustrated in the current number of the *Street Railway Journal*. The method employed is that of using emery-wheels to true the wheel faces without removing the axle from the car. The emery-wheels are mounted on slide rests on a firm foundation, and are driven by belting from an overhead countershaft. This in turn is driven by a motor. The following is the method of working: The journal-box lid is first removed, which exposes the end of the axle. The car is then jacked up till the wheel stands about 1in. clear of the track. Then a male centre on the machine is adjusted to the centre in the car axle and pushed home. This ensures that the emery-wheels will always work at a given radius. The emery-wheels are then started revolving at the edge of the wheel. At the same time the car wheel is made to revolve by its own motor at about 100 revolutions per minute. Then, as the cut is taken, the emery wheels are fed in by the movement of the slide rest. It is claimed that by this machinery a wheel can be ground up true in from 20 to 30 minutes. As it would take almost as long to dismantle the gear if the axle was to be removed to be ground elsewhere, the saving, both in labour and time, would more than warrant the first cost of the above simple machinery.

Northampton Institute.—The vacant appointments at the Northampton Institute, Clerkenwell, have been filled at a meeting held on Monday last. The following were the successful candidates: The head of the mechanical engineering and metal trades department is to be Mr. John Ashford, who has been for the last three years lecturer on engineering at the Birmingham Technical Schools. Mr. Ashford has great experience of the metal trades of Birmingham, and his classes there were largely attended by students of the same type as are expected at the Northampton. The head of the artistic crafts department is Mr. John Williams, who has for several years taken an active part in the movement for the advancement of the decorative handicrafts, and during the last five years as senior instructor and inspector to the Surrey County Council organised and arranged the system of handicraft teaching with successful results. The chief assistant in the applied physics department is Mr. C. V. Drysdale, a distinguished student of the Finsbury Technical College and the Central Technical College, South Kensington, where he obtained two diplomas of associateship in physics and engineering respectively. Since his college training Mr. Drysdale has been for three years employed with Messrs. Nalder Bros. and Co., the electrical instrument makers in Clerkenwell. In the domestic economy school the head teachership has been conferred upon Miss Mary A. H. Gibbs, and the subordinate appointments are Miss G. G. Hardy and Miss Morgan.

Carrying Goods on Street Railways.—The practice of carrying goods on tramways is, we believe, somewhat new in this country. There are many tramlines where personal luggage is charged for, and one or two where small parcels are delivered *en route*. The running of cars

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for a goods traffic only is, however, a paying branch of several lines in America. It is not allowed to interfere with the passenger traffic, but with long suburban lines that can be easily avoided. The *Street Railway Journal* has been collecting information under this heading, and finds that of 199 companies 136 do not attempt a service of this kind. The remaining 63 companies who do carry goods send in conflicting evidence as to the profits to be made. The majority of these carry mails, and most of the contracts for such work show a profit. The general goods required to be carried vary very much with the district. Thus, one company has established a most paying traffic in vegetables. Sidings have been provided to the various market gardens, and the goods are carried over the companies' lines to the railway depôts. In this way the object of our Light Railway Bill is fulfilled, and the profit of the line increased by the combination. We shall be only too pleased to see the tramlines round London equipped electrically, and when this has been done we believe that the same class of traffic would add largely to the revenue. The London markets are all held in early hours of the morning, so that the traffic from the market gardens could be carried out after the passenger cars had ceased running.

Water Power.—After remarking that the production of electricity for lighting purposes has hitherto depended principally on the use of steam power, the *Scotsman* says that there must be many small towns and villages in Scotland where its production by water power would be less costly than by the use of coal, and where electric light might be supplied at a less cost than gas. The water power of the country, which at present is for the most part allowed to run to waste, must sooner or later be economised in the interestof cheap production, and especially in the production of the electric light for the use of the smaller communities. In this direction a good example is being set in the Highland district of Lochaber, which has hitherto held anything but a forward position as an industrial centre. Foyers is outside Lochaber, but on its borders, and the Lochaber district is capable of furnishing water power immensely greater than that of Foyers, and none the less valuable because it can be applied at almost innumerable points and for a greater variety of industries. Some years ago the mansion-house of Achnacarry—Cameron of Lochiel's—was lighted with electricity, the power for producing which was obtained from the River Arkaig, the upper part of the Lochy. Inverlochy Castle, the residence of Lord Abinger, was about the same time supplied with electric light, the source of power being a small mountain stream, one of the Lochy's tributaries, and the use of the electric light in those neighbouring mansions suggested its employment for lighting Fort William. It may be added that this latter work, though a small affair, is not without some points of interest, and a brief description of it will be found elsewhere in our columns.

The Courage of Conviction. — It is frequently suggested that if members of local authorities were more enterprising in regard to the adoption of electric lighting, it would be better for their constituents. On the other hand, not so frequently, but yet sometimes, the town council goes in advance of its electors. Bury St. Edmunds, for instance, is a country town in West Suffolk that has been hit particularly hard by the prevailing agricultural depression. Down there, like Enid, their hoard is little, but their hearts are great. Nevertheless, when a majority of the Town Council proposed to light the whole of the streets with incandescent electric lights and to borrow £20,000 or more to do it, some of the ratepayers got a little alarmed. That being so, although the proposal for the Corporation to undertake the electric supply was carried by a majority, the town councillors who composed it now propose to form themselves into a company and do the work of electric supply at their own risk instead of that of the ratepayers. Whatever may be the financial result of the venture, it is impossible not to admire their courage, and the whole affair contrasts very well with what has happened at Bangor. There is a growing feeling that enterprises like light, water, or tramway work, which must necessarily be monopolist in character, are better in the hands of the municipality than of a private company. But when, instead of the company being an outside one, composed of shareholders living at a distance and having no care for the interests of the town, it is really made up of men who are or might be the town councillors of the borough, the objection to the private company system is greatly minimised.

Separation of Tellurium. — A method for the separation of tellurium from copper residues has been described by Mr. Cabell Whitehead in the *Journal* of the American Chemical Society. In the electrical refining of copper the washings from the gold residues contain the tellurium as tellurous oxide or sulphate. The tellurium may be obtained from these either by precipitation with copper or by passing sulphurous anhydride through the solution. It may be finally purified by distillation in hydrogen. When a solution of sodium tellurite is added to a solution of an ammonium salt a white precipitate of tellurous anhydride is thown down, which becomes granular on boiling. A small amount of tellurium or of some metal which can be precipitated by sulphurous anhydride remains in solution; this soluble portion is still under investigation. Potassium ferrocyanide does not react with tellurium chloride at once, but after a few hours Prussian blue is formed. When tellurium is heated with aluminium the two combine with explosive violence, forming a chocolate-coloured compound difficultly fusible, which has the composition of Al_2Te_3. It is hard and brittle, and can readily be ground to powder; when exposed to moist air it is decomposed and hydrogen telluride is slowly evolved; when thrown into water it is rapidly decomposed. Tellurium is readily deposited by an electric current either from an acid or alkaline solution. It has been found possible to separate tellurium from copper by adding an excess of sodium hydroxide and about three grammes of potassium cyanide for each gramme of copper present, and passing an electric current through the solution, when the tellurium is thrown down as a black, non-adherent precipitate, which can readily be filtered off; the solution can then be slightly acidified with sulphuric acid, and the copper estimated in the usual way by electrolysis.

"Cassier's Magazine."—The August number of this magazine contains several articles which will be of interest to the electrical engineer. An automatic coal weigher, for instance, is described by Mr. Francis H. Richards, and would be of great use to central-station men for keeping their coal records above reproach. There is one article, however, by Mr. G. S. Strong which we feel called upon to notice unfavourably. It is headed "The Future of Power Development." The author commences by stating the well-known fact that electricity is not a source of power, and then proceeds to devote a good proportion of his space to figures showing that it is not a good distributor of power. He starts with the assertion, to which the editor of *Cassier's* takes exception, that the cost of the works at Niagara has been so high that the power costs more than the corresponding cost of power in a coalfield district. The next amazing statement is that a locomotive generates power more economically than a stationary engine. The author

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considers that the electrical generating plant takes nearly 4lb. of coal per horse-power, and that a locomotive can be made to work inside 2lb. It is the old method of comparing trial trip figures with average working costs, and such special pleading is useless. The author finally compares the cost of equipping a railroad electrically and the cost of steam locomotives. We are sure that there would be no difficulty in getting a contractor to undertake the work at his figure for electrical equipment, as one such contract would make his fortune. After appreciating the cost of outfit, the author proceeds to review the cost of working, on the assumption that the engines in the electric stations will require more coal than the locomotive. It is therefore quite a relief to proceed with him to a new subject, which happens to be that of gas-engines and gas-producers. We trust that the editor of the magazine will have an article in his next issue confuting some of the figures given. The biographical notes about Mr. C. F. Brush, of arc-light fame, and the paper by A. E. Childs on storage batteries for central stations, are also interesting reading.

Rontgen Radiations.—According to telegrams in the daily papers, at a psychological congress at Munich there has been a Röntgen ray demonstration, at which a "living human body (why not say a man and save two words of the telegram) was placed under the action of the rays," and observers were able to watch the action not only of the osseous parts of the body, but also of the diaphragm, stomach, and heart. How it was done is not said, except that it is mentioned that "specially prepared tubes" were used. Probably higher vacua than usual and an extra high voltage were adopted. In this connection it would be interesting to know what is the precise effect of using anodes of less density than platinum on the penetrating power of the rays and varying the nature of the residual gas in the tube. The latter ought to have a very considerable influence on the result, but it must be remembered that though theory may give some hints as to the way to get a particular kind of wave length, there is also the question to be considered of whether the fluorescent screen or the photographic plate will respond to it. Lastly, it has been gravely announced that a discovery has been made—and made in Germany, though not at Munich—that the aurora borealis is caused by Röntgen radiations emitted from the sun making the air fluoresce. That the aurora is seen at night does not seem to have occurred to the discoverer. It is really quite remarkable how a subject like the new radiations, which obviously required in anyone dealing with it some acquaintance with the conceptions of physics, should from the beginning have been selected as a happy hunting-ground for that numerous class of people who, being without clear ideas in the matter, are as fertile in suggestions as they are incapable of understanding the experimental proofs of their futility. But perhaps even this is not more remarkable than that the really eminent persons who interested themselves in the subject did not sooner see that phenomena which were as familiar to them as their alphabet were entirely fatal to the original hypothesis of longitudinal ether vibrations.

Grades on Tramways.—A summary of a paper by Mr. Foster on the subject of grades, which was read before the California Street Railway Association, has been given in the New York *Electrical World*. Mr. Foster discusses in general the ascending of grades, and gives brief descriptions of a number of devices used in the Pacific Coast cities where there are very steep grades. There has prevailed a misconception as to the power required by an electric car on a grade, as the speed does not remain the same on the grade as on the level. As the work to be done increases, the car speed decreases until the power is within the limits of the motors. Diagrams are given showing how the speed decreases up to 14·5 per cent. grades, as also a curve showing what the power would be if the speed remained constant. The motormen are usually instructed to use only the series notch on heavy grades, as it is more economical to run the motors in series than in multiple. This question Mr. Foster discusses, and finds that from the standpoint of the repair shop the series combination is the cheaper; from the standpoint of the power-house engineer it is also better, as the plant can handle twice as many cars as if they were run on the multiple notch. From the standpoint of the investor the series notch is also preferable for grades, lest the station capacity should have to be doubled; but from the standpoint of the watts per car mile, or the coal pile, the multiple notch is found to be slightly cheaper. The current will be more when in multiple, but the time will be less than in an inverse ratio to the current, or, in other words, the speed will be more than in a direct ratio to the current. This saving, however, is not worth considering, as it is undoubtedly more than counterbalanced by the disadvantages. Theory states that the amount of "power" (evidently work or energy is meant) required to propel a car up a grade is independent of the speed, for with greater speeds the time during which it is exerted is shorter. But there is a disagreement between theory and facts owing to the relative car efficiencies at the two notches, it being higher at the multiple notch. It is often asked what the steepest grade is that can be ascended—a question not easily answered. Mr. Foster states that it is not so much a question as to how steep a grade can be climbed as how steep a one can be safely descended. In San Francisco grades of 14·54 per cent. are operated successfully in both directions, and at Oakland 14·25 per cent. In Seattle a single-truck car climbed a grade of 16·85 per cent., 500ft. long, but the car was not allowed to descend it without an outside check on its speed. If the car is brought practically to a stop at the top of a grade and then let down at six or eight miles an hour, the danger of a runaway or flattened wheels is very slight. Some motormen use a method which allows them to descend rapidly with the brakes on, and yet not slide the wheels; this is done by putting the controller on the series notch while the brakes are set. The maximum braking effect is when the pressure is just under the skidding point; but the idea of using power while descending grades is the reverse of what engineers seek to realise. It may be argued that a car can be stopped more quickly by causing sliding wheels to rotate than by letting them slide, but in a test it was found that the pull per ton required to tow a car with the brakes set decreases from 42lb. to 5lb. as soon as the wheels slipped. It would be much cheaper, however, to allow the wheels to turn by slacking of the brakes than to do it by using the current. At Mount Lowe two cars are permanently attached to the opposite ends of a cable that passes around a winding drum at the top of a grade, and the force of the descending car aids the ascending one. In Fillmore-street, in San Francisco, there is practically a double track and the descending car aids the ascending one as at Mount Lowe, but the difference between the loads is made up by the use of motors. At Seattle there is a single track with a second one below it in a conduit; the descending car pulls up a load of pig iron as a counterbalance below, until it reaches a level track above; the next ascending car pulls the endless cable and thus starts the counterbalance down the grade.

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THE NAGLO EQUIPMENT FOR TELEPHONE EXCHANGES.—SYSTEM HESS-RAVEROT-WEST.

BY JULIUS WEST.

(Concluded from page 129.)

For 20 groups *a-u* we obtain the following arrangement, in which the *i* cables, for example, may be carried in the simple manner indicated by the two lines:

aabcadbeafbgahbi | *akblambnaobpaqbrasbtaubb*
ccdecfdgchdi | *ckdlcmdncodpcqdrcsdtcudd*
eefgehfi | *ekflemfneofpeqfresfteuff*
gghi | *gkhlgmhngohpgqhrgshtguhh*
| *iiklimkniokpiqkrisktiukk*

llmnlomplqmrlsmtlumm
nnopnqornsotnuoo
ppqrpsqtpuqq
rrstruss
ttuu

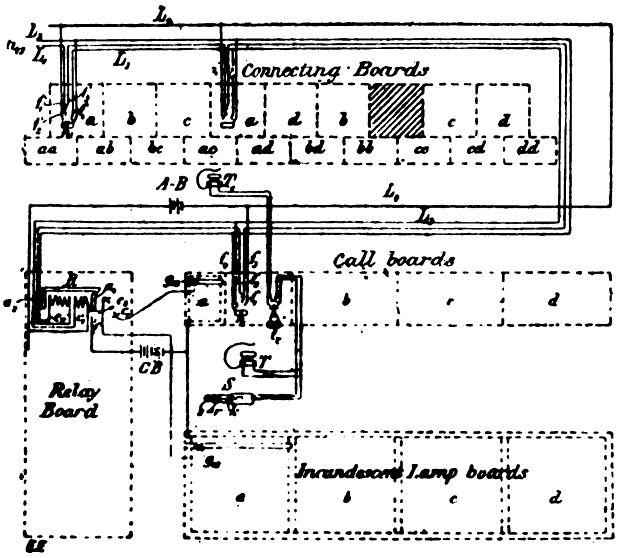

FIG. 2.

Fig. 2 represents the general plan of connections for an exchange with four groups. The equipment consists of the combination boards, on which the connections

and an incandescent lamp board, which optically indicates whether the wires are free or engaged. The double wire of a subscriber in group *a* are led first through two panels of a combination board, the switches for the outward line being connected in series, for the return line in parallel. From the combination board the wire runs to the callboard of group *a*, where it connects with a similar plug switch, and from here it goes to the call relay, R, in the relay-board. This relay is designed on the principle of the well-known self-erecting annunciators of the Western Electric Company. The front armature of this relay can assume three positions—the middle or position of rest, as shown; the drop position, in which spring *f* presses against the bottom contact, c_1; and the erect position, when spring *f* makes contact with c_2. In the drop position *f* closes the circuit of an incandescent lamp, g_{12}, mounted on the callboard, whilst in the erect position it inserts an incandescent lamp of the same number (g_{12}) mounted on the lampboard, which, as mentioned before, indicates optically for the whole exchange whether the subscribers' lines are free or engaged.

Besides the two telephone lines, L_1 and L_2, of the subscriber, there is a third line, L_3, commencing at the erecting coil, e_1, of the call relay, and leading to the contact springs, f_4, of all the switches of the respective subscriber lines. A further line, L_4, common to all the switches of the whole exchange, branches off to the spring, f_1, of the switches, and on the other side of the erecting battery, A B, to the various relays.

The mode of working is now as follows:

When the subscriber (*a* No. 12) calls up the exchange, the erecting magnet, e_2, attracts its armature, a_2, thereby releasing the front armature, a_1, which drops forward and

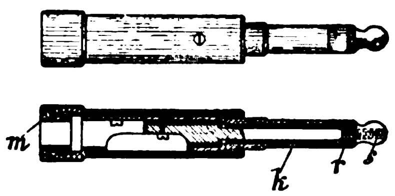

FIG. 5.

closes the circuit of lamp, g_{12}, on the callboard. The lighting up of this lamp is the call for the operator, and he now inserts a triple plug, S (connected to his telephonic instrument, T), into switch, k_{12}, thus switching himself on to subscriber (*a* No. 12) as the body of the plug, *k*, touches the cylinder, *h*, and point, *s*, the spring f_2, which it lifts off spring f_3. This cuts out the call electromagnet, e_2, of the relay from the telephone circuit, and the local circuit is being completed by means of erecting magnet, e_1, as the insulated ring, *r*, of plug, S, connects the springs f_1 and f_4,

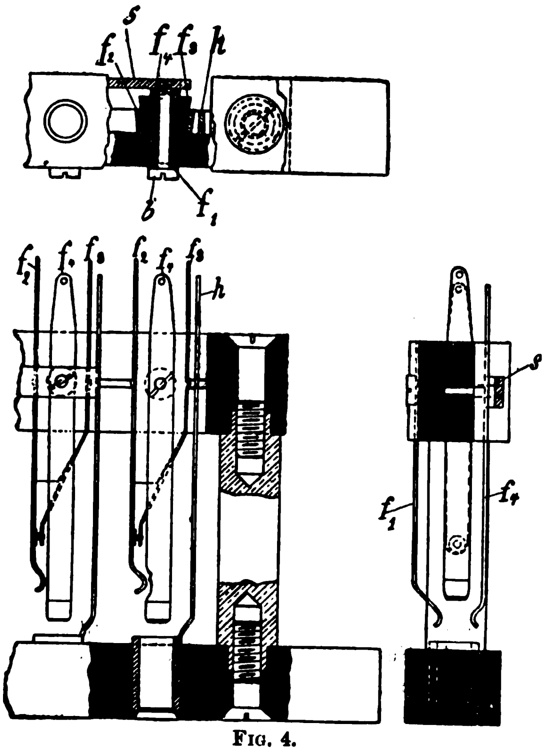

FIG. 4.

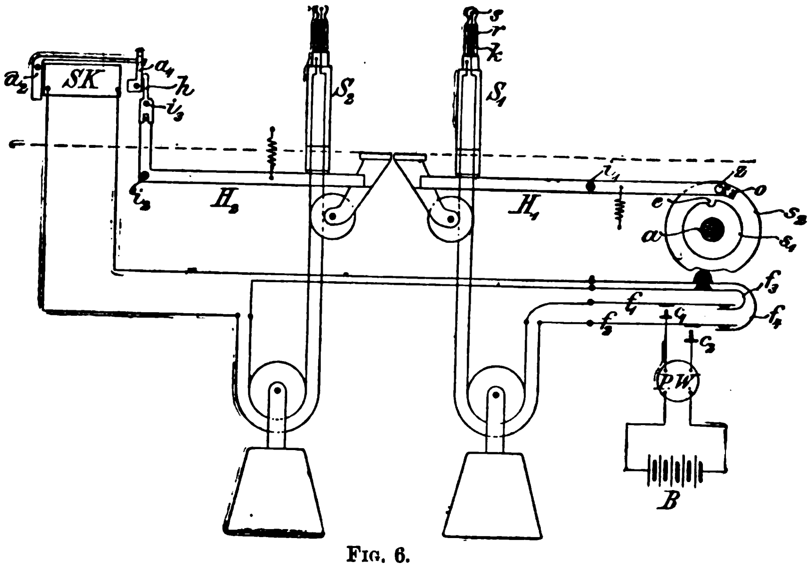

FIG. 6.

between subscribers are effected; the callboards, on which the subscribers' orders are received; the relay-boards, which contain the call annunciators (designed as relays);

thereby causing e_1 to attract its armature, a_1, and to interrupt the lamp circuit, g_{12}, on the callboard, in place of which lamp g_{12} on the lampboard is inserted. This lamp thus

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burns as long as any switch of the respective connection is plugged and shows that wire *a* No. 12 is engaged.

After having inserted his plug the operator replies as usual, "Here, central" and receives from the subscriber the number of the desired connection—for instance, *b* No. 209; he now glances beyond his board at the lampboard to see whether the wire is free or not—that is, whether lamp 209 in panel *b* is burning. In this case he answers, "Wire *b* 209 engaged" and withdraws his plug, whereby the local circuit of the electromagnet e_1 becomes interrupted, armature a_1 turns forward until arrested by the drop lever in the position illustrated, and lamp g_{12} on the lampboard of course ceases to burn.

If, however, line *b* No. 209 is free the operator has to transmit the order to the operator on the combination board; for this purpose his table contains a number of keys, by means which he can put himself in telephonic

The following points are therefore of importance when determining the size of the groups: (1) the number of simultaneous connections during the busiest hours; (2) the number of simultaneous connections which an operator can manage during the average duration of a conversation. It is not possible to alter the first figure by constructive considerations, but the second figure depends to a very considerable extent upon the design and efficiency of the system. This is an inducement to make the manipulation of the connecting cords as simple and speedy as possible. This has been attained in the present system by effecting some manipulations, which are required at each connection, at the proper moment and without help of the operator, simply by automatic mechanism, so that the operator has simply to insert and withdraw the plugs, and is therefore enabled to attend to 30 pairs of plugs.

Takin' this figure as our basis, we arrive at the size of

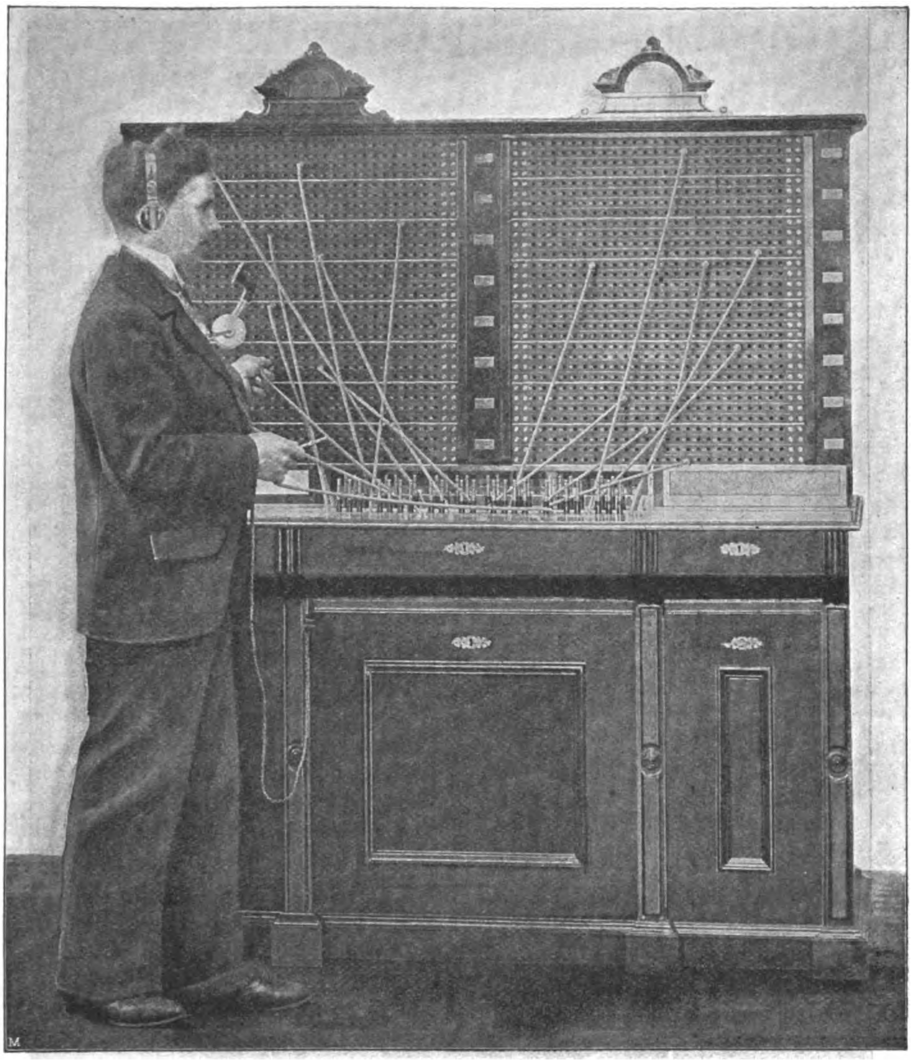

FIG. 3.

communication with those operators who are able to effect combinations with his group (*a*)—namely, *a a*, *a b*, *a c*, *a d*; the respective keys are marked *a b c d*. In this instance he presses key *d*, marked t_d in the figure, and simply gives the order, "*b* 209 with *a* 12," whereupon the combination operator at once connects the two corresponding plugholes by means of a double cord; at the same time the respective relays are cut out of the speaking circuit, and the proper lamps on the lampboard begin to burn. On receiving the disconnecting signal the connection is withdrawn, and the lamps become extinguished.

As is obvious, the groups ought to be made as large as possible, for the larger they are the smaller will be their number, and the smaller the number of necessary switch-panels. The number of subscribers in a group must, however, be selected with a view of enabling the operator on the combination board to manage all the connections between two groups.

the groups as follows: For an exchange with 10,000 subscribers and frequent calls about 1,300 cords are required (inclusive of the necessary reserves) in order to cope with the calls during the busiest hours of the day. If we subdivide the whole of the 10,000 subscribers into 10 groups of 1,000 subscribers each, we require according to the system of combination 44 working places, which, with 30 cords for each, give 1,320 cords, this number being sufficient to deal with the connections, so that the sub-division is practicable. Of course, this figure varies according to special circumstances; generally speaking, it varies between 700 and 2,000 subscribers per group, the higher figures being resorted to for large systems, as, on the whole, the increase of calls does not keep pace with the growth of the system, but lags somewhat behind it.

The experimental equipment here to be described contains 800 subscribers in each group. Fig. 3 shows the first combination board, *a b*, which corresponds to the first

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working place of the row; it contains 30 pairs of plugs on the plug-board, and the illustration shows the two switch-panels, *a* and *b*, with 800 switches in each. The dimensions are determined by the width necessary to ensure the free movement of the operators standing side by side; it has been fixed at 65cm. (26in.), which size, together with the small number of switches per panel, allows us to place these a fair distance apart, which, from a technical point of view, is essential. The switch-rows, containing each 25 switches, are separated by narrow strips of yellow wood, and the groups of 100 switches by wider white strips, facilitating the location of the plugholes.

Fig. 4 gives the construction of a switch-row in detail; the only loose contact has vertical springs, f_2 and f_3, with platinum contacts, which are, moreover, rubbing contacts, since f_3 is elastic, so that contact irregularities are guarded against as far as possible; bar *s* corresponds with wire L_4 in Fig. 2.

Fig. 5 shows the plug in detail, and requires no special explanation.

The automatic arrangements mentioned above consist of a simple lever gear, which automatically raises the annunciator flap, and of a switching gear, which comes into action the moment a plug is raised for making a connection, and which, for the space of four seconds, sends a call current into the subscriber lines.

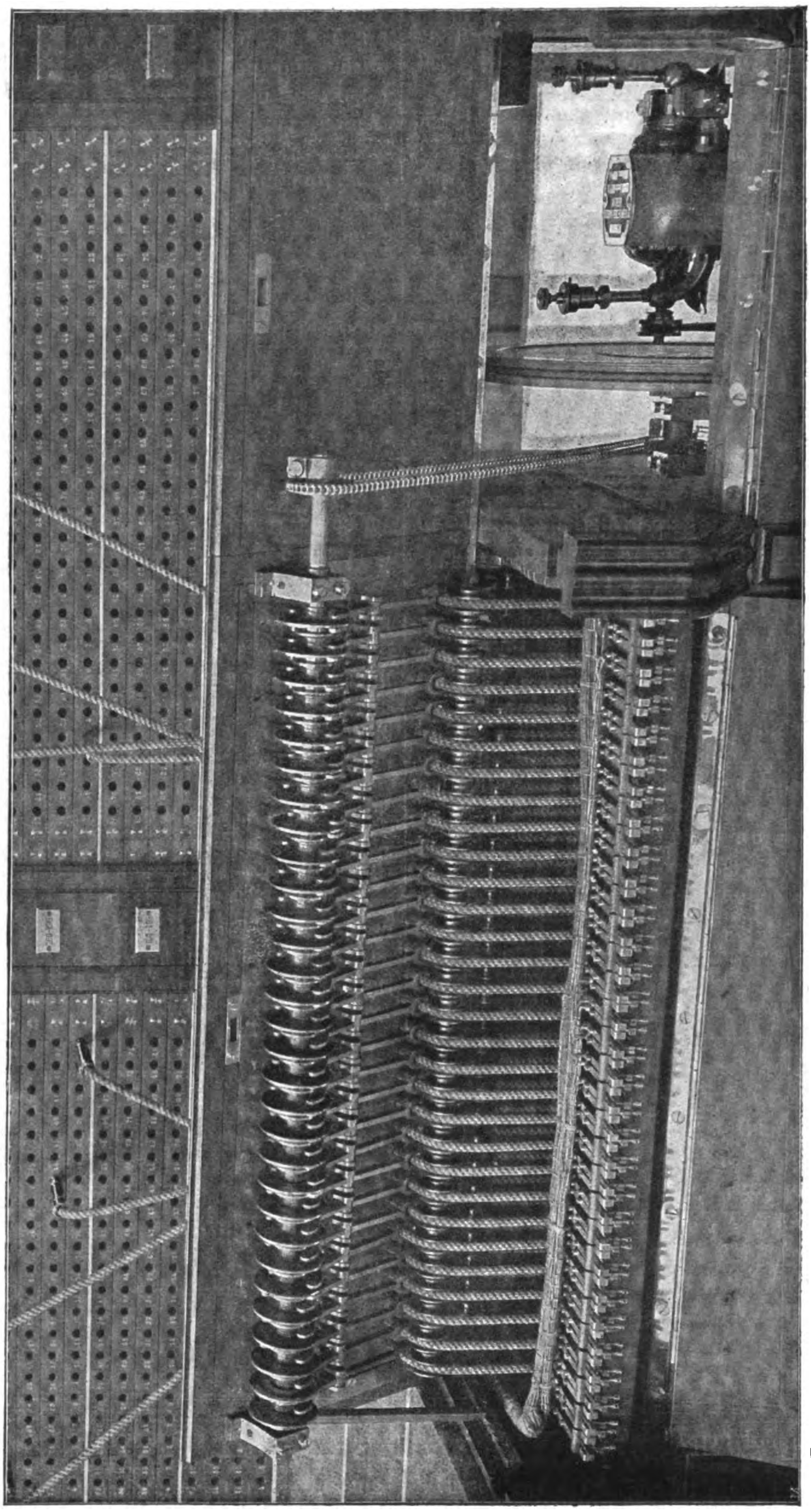

Fig. 7.

These two mechanisms are sketched in Fig. 6. The front plug of a cable rests on a double lever, H_1, with a fulcrum, at i_1, bearing on its outer (right side) end a pin, *z*; on the spindle, *a*, which is kept in slow rotation from a small motor (making one revolution in about five seconds), the two discs, s_1 and s_2, firmly connected together, are placed

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so that they tend, by friction on the spindle, to turn with it. As long as H_1 remains in the position shown, this tendency to revolve is counteracted by the knob, *o*, on disc s_2 bearing against pin, *z*, but on lifting the plug S_1 the lever, H_1, swings round *i*, pin, *z*, going down until it touches against the flange of disc s_1, so that knob, *o*, is disengaged, and allows both discs to follow the rotation of the spindle, *a*, at the same time depressing the contact springs, f_4 and f_3, and effecting electrical contact between f_1 and f_2 and the battery contacts, c_1 and c_2, and simultaneously breaking the connections between f_1 f_3 and f_2 f_4; plug S_1 has meanwhile been inserted in the plughole of the subscriber wire, and battery, B, sends now a call current into it (through the pole-changer, P.W.) for about four seconds, until the discs have turned so far that the insulating piece between f_3 and s_2 drops again into the groove of s_2, re-establishing the connections as sketched; a moment later groove *e* engages with pin, *z*, arresting discs, s_1 s_2. At the termination of the conversation the plug drops back on lever, H_1, lever, *h*, pivoted in i_3, which gears into H_2. If S_2 is raised, the right end of H_2 swings upward and the upper end of *h* to the right. On receiving the termination signal, annunciator, a_2, is released, turns forward until stopped by *h*; when S_2 is pulled out of the switch it falls back upon H_2 and turns this, *h*, and a_2 back into the initial position.

The callboard (Fig. 8) is divided into working places of 200 subscribers each, containing a lampboard with 200 incandescent lamps, and below this a switch-panel with 200 plugholes; besides, there are on the left of each switch-panel three keys for the speaking lines to the three combination boards, *a b*, *a c*, and *a d*.

The lamps are arranged 20 in a row, and covered by brass thimbles, the front ends of which are closed by dark-green glass discs. The back of each disc is thickly painted over with matt white paint, in which a number is cut out, backed by a disc of white parchment paper; with this arrangement the number is invisible when the disc receives front light, but appears, however, green against a dark back-

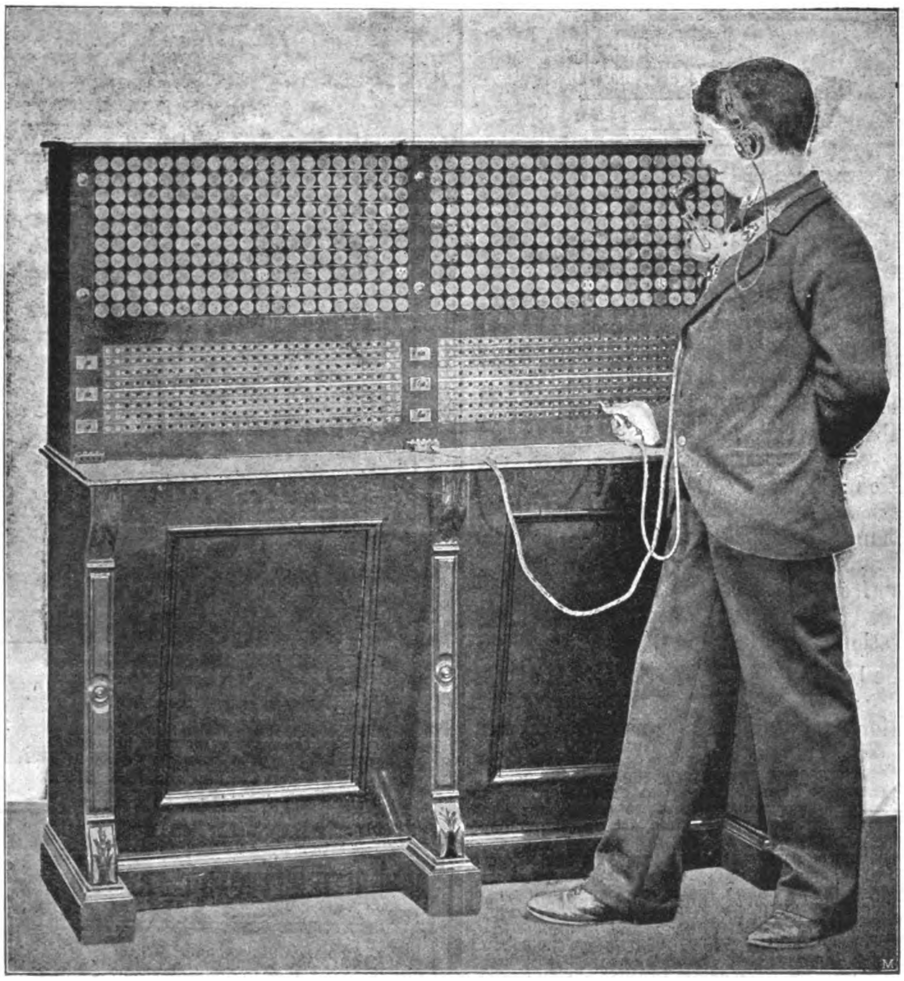

FIG. 8.

turning it back to its initial position, making discs, s_1 s_2, free again to turn until *o* presses against *z*.

Fig. 7 illustrates the constructive details of this automatic mechanism; it represents the combination board with the plugboard opened; on the right side is the small shunt motor, which slowly turns the spindle, *a*, by means of a double cord transmission and chain-wheel. This spindle carries the 30 discs for the 30 cables, and is supported by two bearings, which, with the fulcrums of the 30 switch levers, are fixed to a metal plate screwed to the underside of the plugtable. Instead of the friction arrangement as above sketched, the discs are geared by the help of the lever to the spindle through simple toothed wheels. Of the loose cables, the contact parts marked f_1, f_2, f_3, and f_4, as well as c_1 and c_2, and their wires, are visible. In order to ensure the smooth and undisturbed movement of the pulley weights, partition walls of sheet iron have been inserted between these.

The raising mechanism of the annunciator flap, S K, consists of a lever, H_2, turning round spindle, i_2, and of a small ground when the incandescent lamp burns, the white paint being opaque to the light.

The 20 lamps of each row are fixed on a common iron bar, S (Fig. 9), which through rail *r* (common to the 10 rows of lamps) communicates with one pole of the battery. A so-called "attention lamp" is also switched in circuit, and lights up whenever one of the 200 subscriber lamps is inserted into circuit. The operator, therefore, does not need to watch the whole lampboard, as the attention lamp indicates when there is a call. This is of special advantage when one operator has to attend to several working places during the quiet business hours or during the night. Behind the iron bar is fixed a wooden beam, L, supporting the connecting springs, *f*, for the centre pole of the lamps. The protecting thimble, R, fixes on to the metal socket of the lamps by means of a bayonet fitting, and can be easily removed from the front should it become necessary to replace a lamp, and as the lamp voltage is but four volts the thimbles may be safely handled.

As speaking instruments the operators use a head tele-

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phone and chest microphone (see Figs. 3 and 8) of the Ericsson pattern. It allows great freedom to the movements of the operator.

The incandescent lamp board (Fig. 10) is sub-divided into panels of 100 lamps each. Of the eight panels only four are fitted, and of these three are provided with white and one with green number glasses, the latter of which appears to be of greater advantage. The design is the same as in the lamps on the callboard.

The relays of each group are arranged in a glass-fronted double cupboard, so that the dust is kept from the contacts, as will be seen from Fig. 11. Ten relays are mounted on a board, which slides out, the connecting wires visible in the illustration being in reality replaced by spring contacts on the inside of the backboard, so that the relay-boards

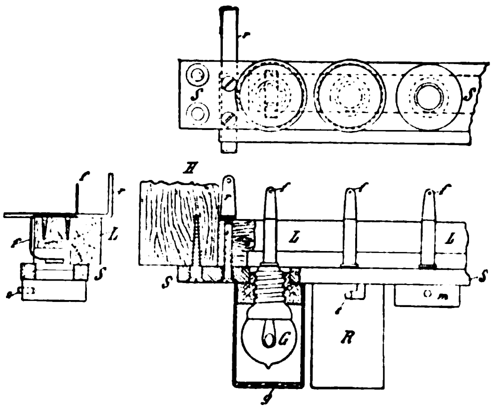

Fig. 9.

may be exchanged within a few seconds; the cables are carried along the outside of the cupboard back.

The work of the operators is now as follows:

A.—If the desired subscriber wire be engaged.
On callboard *a*.

1. First manipulation: plugging the switch of calling subscriber 12.
2. Report: "Exchange, here." Receiving the desired number b_{15}. Examination by looking at lampboard whether b_{15} be free. Answer to caller, "Wire b_{15} engaged."
3. Second manipulation: withdrawing plug 12.

B.—If the desired line be free.
On callboard *a*.

1. First manipulation: plugging the switch of calling subscriber 12.

3. Second manipulation: pressing key *b* and reporting to combination operator, *a b*, "b_{15} with a_{12}."
4. Third manipulation: withdrawing plug 12.
On combination board *a b*.

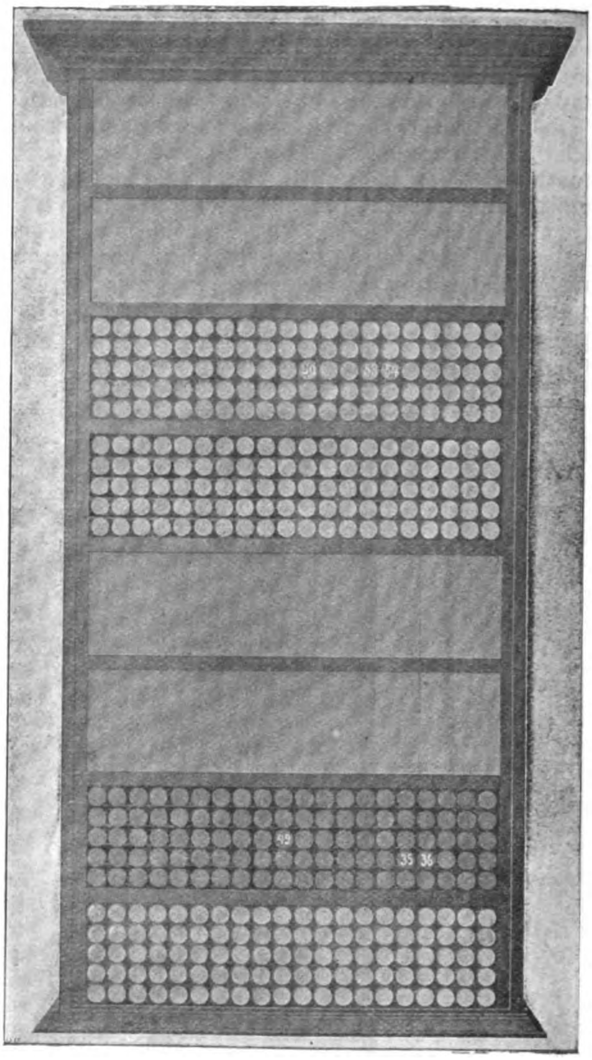

Fig. 10.

5. Fourth manipulation: plugging switch b_{15}.
6. Fifth manipulation: plugging switch a_{12}.

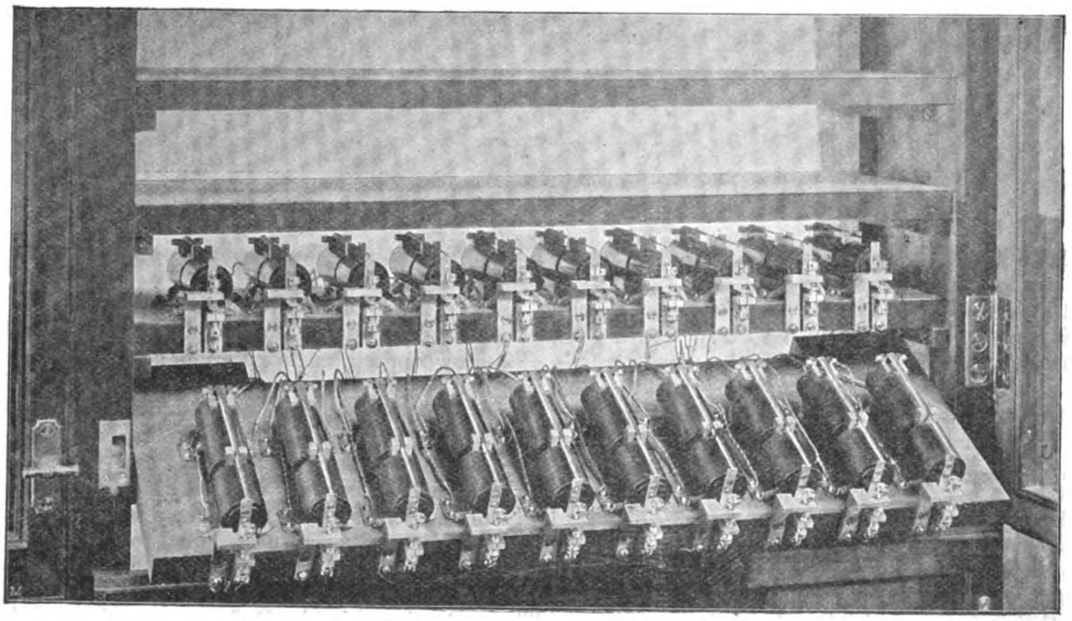

Fig. 11.

2. Report: "Exchange, here." Receiving the desired number b_{15}. Examination by looking at lampboard whether b_{15} be free.

7. Sixth manipulation: withdrawing plug a_{12}.
8. Seventh manipulation: withdrawing plug b_{15}.

During hours of great pressure the manipulations of the

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call operator A_3 and A_1 for the following call are effected together, likewise B_4 and B_1, so that the work, if the wire be free, is reduced to six manipulations for effecting and interrupting a connection, and to one manipulation if the wire be engaged.

At the same time there is a check for the proper execution of each manipulation. If a wrong hole is plugged at A_1 and B_1, then the call incandescent lamp will continue to burn, drawing at once the operator's attention to the mistake, instead of necessitating the usual waste of time by calling repeatedly in the wire, "Here, exchange."

During manipulation B_3 the subscriber remains in circuit, and thus, hearing the transmission of his order, may, of course, check the correctness of same, and eventually may call "wrong" and repeat the proper direction. The call operator can also check the manipulation b_{15} with a_{12} on the combination board, for in the case of proper handling b_{15} lamp must light up in the lampboard, and a_{12} lamp, which is already alight, must continue to burn when he withdraws his plug from switch a_{12}.

The groups have up to now been denominated by the letters of the alphabet, but as consonants like *b p w*, *m n*, *d t c* are difficult to distinguish by telephone, they have been replaced by short, crisp names beginning with the respective letter.

As regards the arrangement of the equipment, it stands to reason that only the lampboards and the callboards need be in the same room, the other instruments being placed wherever convenient. In larger exchanges it would be advisable to provide a room for the callboards, incandescent lamps, and relays, and another room for the combination boards.

In an exchange for 40,000 subscribers the callboards require a hexagonal room of about 20 yards diameter; these boards are placed in four rows running parallel with the walls, so that each row rises towards the centre of the room about half a yard against the outer one. The operators turn their backs to the centre of the room, and have thus a complete and uninterrupted view of the walls in front of them, which are covered by four complete lampboards in such a way that each board with 40,000 lamps covers 1½ walls. (There are thus four lamps in each circuit to indicate the state of the subscriber wires.) With this arrangement the greatest distance between operator and the farthest of his lamps is only 10 yards, so that the numericals are easily distinguished.

In the formula given for 20 groups we require 211 work places, each of which, with 30 cable pairs, gives 6,330 pairs, this number being sufficient for 40,000 subscribers, even making provision for an increase in the work, so that we have 2,000 subscribers per group.

The combination board represented by the table requires a room of about 20 yards by 22 yards if we take away the places to the left of the vertical line and place them as indicated below, so that they fill the vacant space at the bottom.

i	*a*	*k*	*b*	*l*	*a*	*m*	*b*	*n*	*a*	*o*	*b*	*p*	*a*	*q*	*b*	*r*	*a*	*s*	*b*	*t*	*a*	*u*	*b*	*b*
i	*c*	*k*	*d*	*l*	*c*	*m*	*d*	*n*	*c*	*o*	*d*	*p*	*c*	*q*	*d*	*r*	*c*	*s*	*d*	*t*	*c*	*u*	*d*	*d*
i	*e*	*k*	*f*	*l*	*e*	*m*	*f*	*n*	*e*	*o*	*f*	*p*	*e*	*q*	*f*	*r*	*e*	*s*	*f*	*t*	*e*	*u*	*f*	*f*
i	*g*	*k*	*h*	*l*	*g*	*m*	*h*	*n*	*g*	*o*	*h*	*p*	*g*	*q*	*h*	*r*	*g*	*s*	*h*	*t*	*g*	*u*	*h*	*h*
	i	*i*	*k*	*l*	*i*	*m*	*k*	*n*	*i*	*o*	*k*	*p*	*i*	*q*	*k*	*r*	*i*	*s*	*k*	*t*	*i*	*u*	*k*	*k*
					l	*l*	*m*	*n*	*l*	*o*	*m*	*p*	*l*	*q*	*m*	*r*	*l*	*s*	*m*	*t*	*l*	*u*	*m*	*m*
i	*h*	*g*	*g*						*n*	*n*	*o*	*p*	*n*	*q*	*o*	*r*	*n*	*s*	*o*	*t*	*n*	*u*	*o*	*o*
i	*f*	*h*	*e*	*g*	*f*	*e*	*e*						*p*	*p*	*q*	*r*	*p*	*s*	*q*	*t*	*p*	*u*	*q*	*q*
i	*d*	*h*	*c*	*g*	*d*	*f*	*c*	*e*	*d*	*c*	*c*						*r*	*r*	*s*	*t*	*r*	*u*	*s*	*s*
i	*b*	*h*	*a*	*g*	*b*	*f*	*a*	*e*	*b*	*d*	*a*	*c*	*b*	*a*	*a*						*t*	*t*	*u*	*u*

The other rooms required are small, and are chiefly confined to the accumulator-room, as the relay cupboards may be placed below the lampboard in the callroom.

This economy of space compares favourably with the space required for exchanges on the multiple system. As regards the cost of the equipment, it may be mentioned that for one exchange of 40,000 subscribers it comes out cheaper than for seven exchanges on the multiple system—namely, five exchanges of 6,000 subscribers each, and two exchanges of 5,000 subscribers each.

The number of switches for the new system would be barely 500,000, as against 2,500,000 for the seven smaller exchanges; the number of simultaneously working operators 411, as against 1,000 to 1,200 on the multiple system, if we base our calculation upon the division of working places as at present in force at Berlin—namely, 66 to 67 subscribers, or 10 to 12 combination wires per operator.—*Elektrotechnischer Zeitschrift.*

ALTERNATE-CURRENT TRANSFORMERS.*

BY DR. J. A. FLEMING, F.R.S.

LECTURE III.

(Concluded from page 162.)

One thing that should be noticed in connection with this part of the subject is that the iron core losses in the transformer are diminished as the transformer heats up. The curve in Fig. 42 shows the results of an experiment with a 50-kilowatt transformer. The transformer was taken up when perfectly cold, and its core loss was measured and found to be 983 watts. This transformer was then connected with the circuits, and the core loss was taken at various intervals during a period of 20 hours until the transformer had reached a final constant temperature. It was then found that the iron core loss had fallen to 893 watts. The transformer was then disconnected from the circuit and allowed to cool, observations being taken during that period. After 24 hours the transformer had again become quite cold, and the core loss had risen up to 983 watts. There is, therefore, a difference of 100 watts, or nearly 10 per cent. in the core loss of the transformer when taken hot and when taken cold. This experiment shows the necessity for defining the conditions under which the core loss and efficiency of a transformer shall be taken. It is not enough to specify simply that the efficiency shall be of a certain value. It must be specified under what conditions this efficiency is to be taken, whether with the transformer cold or the transformer warm. In addition to this, there is a variation of the iron core loss taking place with time.

Variation of Core Loss of a 50-K.W. Transformer with Temperature.

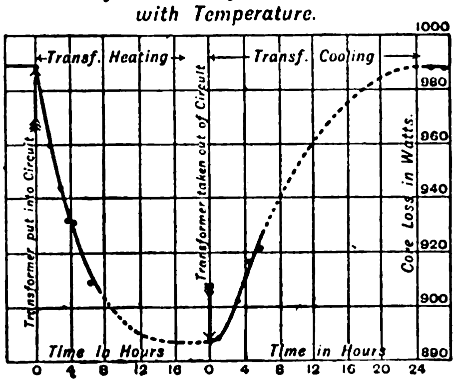

FIG 42.

When a new transformer which has never before been used is connected with the circuits, it is often found that when core loss measurements are made continuously at regular intervals, the core loss goes on increasing, and this may take place to the extent of 40, 50, or even 100 or more per cent. increase. In fact, instances have been noticed in which a core loss has increased in the course of a course of a few months to three times its original value. Mr. Mordey found that he could produce this effect in iron by slow heating. It does not occur in all transformers. In an experiment I specially tried with two new Thomson-Houston 30-kilowatt transformers, which were connected to the circuits night and day for three months, and regularly measured at intervals, no apparent increase in the core loss was found. The reasons for this permanent increase in the hysteresis loss are not yet entirely explained. In the case of some iron which has been very carefully annealed, it is found there is a remarkable rise in the hysteresis loss when this iron was used as the core of a transformer. The same rise is also found in the case of iron which has not been very carefully annealed. We cannot at the present moment state precisely what are the conditions under which this increase in core loss takes place, or what is the constituent in the iron that tends to produce it. It has been supposed by some investigators that the presence of silicon in the iron has a tendency to determine this increase in the hysteresis loss, as the iron is magnetically used. It, however, points to the necessity not only of testing transformers at first when they are purchased and before accepting, but of taking a series of tests of the transformer at regular intervals. Suppose that in a sub-station there are three or four large transformers,

* Cantor lectures delivered before the Society of Arts.

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and that one of these transformers is made the master transformer and is kept connected with the circuits night and day, the others only being switched on during the time of heavy demand; then it is obviously a very important matter that the transformer which is thus made the master transformer should be the one which has the least core loss; and if it should happen that this transformer is one which has largely increased its core loss by use, then it should be exchanged for another which has the least obtainable core loss for that size of transformer. In every sub-station the wattmeter arrangement described at the beginning of this lecture should be capable of being set up in order to make core-loss measurements in a systematic manner. It is perfectly clear that if a few thousand Board of Trade units more than necessary are being wasted in each transformer sub-station, that the total value of these Board of Trade units when added up and capitalised may realise a very considerable sum of money.

Sumpner's Differential Method of Testing Transformers.

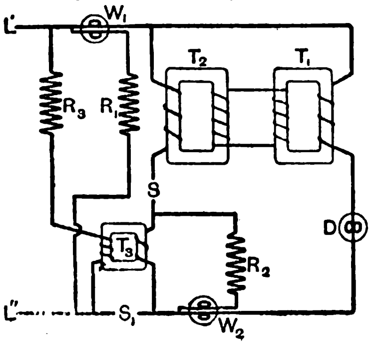


FIG. 43.

For the purpose of testing large transformers in workshops without requiring a large consumption of power, Dr. Sumpner has devised a differential method of testing, the arrangements of which are shown in the diagram in Fig. 43. In this case the power given out by one transformer on the secondary side is put back into the primary circuit by means of another reverse transformer, so that what is actually taken from the primary mains is merely the total loss in the two transformers. This total loss is measured by a wattmeter arrangement, which enables us to measure, therefore, the efficiency of the two transformers taken together, and therefore, if they are identical, the efficiency of either of them. In addition to the efficiency tests, there ought always to be a series of security tests to test the strength of the transformer. In the first place, the temperature should be taken after the transformer has been connected to the mains for 24 hours on open circuit, and then connected to the mains for two hours on full secondary load

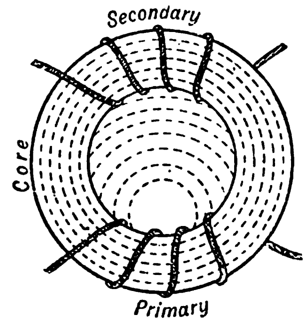


FIG. 44.

This temperature is best taken, as described in the beginning of the lecture, by measuring the resistance of the copper circuits, but it may be checked by means of a thermometer placed inside the case. Under no circumstances should the temperature in the interior of the transformer rise above 100deg. C. In the next place, electric pressure equal to double the primary pressure ought to be put on between the primary and the secondary circuits for at least 15 minutes, and the same double pressure ought to be put on between the primary and case—that is to say, if the transformer works at 2,000 volts on the primary circuit, 4,000 volts should be put on between the primary and secondary circuit for 15 minutes, and 4,000 volts between the primary and case for 15 minutes. In addition to this, the transformer should be tested for several hours at the normal pressure before being put to work. In the case of large transformers which have stood idle for some time it is not wise to put on the full primary pressure at once. The transformer should be gradually warmed up by passing a large current through the secondary circuit of the transformer, the primary circuit being short-circuited. In that manner the transformer will be gradually heated up, any moisture which has been absorbed into the insulating material or into the case will be got rid of, and the transformer will be gradually brought into a condition of high insulation. Transformers which have been standing in the stores for long time may frequently fail if put suddenly on to the working circuits without some such precaution.

Next, with regard to magnetic leakage, it is important to employ some test to ascertain whether there is a large magnetic leakage. Magnetic leakage, as already explained, is due to an escape of induction, linked with the primary circuit, and which does not entirely pass through the secondary. It is promoted by any separation of the primary and secondary coils, as in Fig. 44, but is not entirely eliminated by any arrangement of them, as may be seen by considering the diagrams in Fig. 45. This leakage, of course, can be ascertained by measuring the secondary drop as described above, and comparing that value with the total copper drop as calculated by the rule already given. An experimental proof of magnetic leakage can be obtained by a simple method due to Mr. Mordey. Two thermometers are taken, one filled with mercury and the other filled with alcohol. These thermometers are

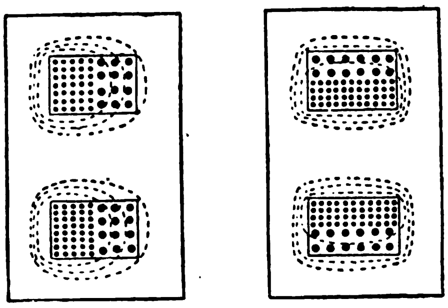
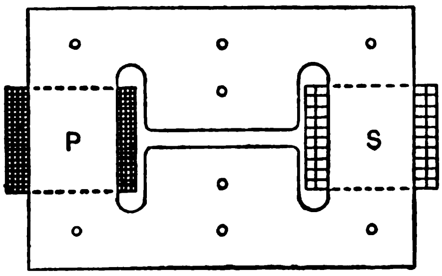


FIG. 45.

compared to see that they are in agreement at the ordinary temperature. The bulbs of the thermometers are then introduced into any portion of the transformer near the secondary coils and kept there for some time. If there is any leakage of magnetic induction outside the secondary circuit, this induction passing through the mercury thermometer will generate heat in the mercury and cause the mercury thermometer to rise, but the spirit thermometer will be unaffected by this process. Hence, although both thermometers will rise from external temperature, if the mercury thermometer rises more than the spirit thermometer it indicates the presence of magnetic leakage at that spot where the bulbs are placed. In some transformers a magnetic leakage is actually encouraged. A transformer, designed by Elihu Thomson, intended to give constant currents from the secondary circuit when the primary circuit is worked off a constant-potential circuit, is constructed as shown in Fig. 46. In this case there is a kind



Thomson-Houston, Constant Potential to Constant Current, Transformer.

FIG. 46.

of iron bridge interrupted by an air-gap across the core between the primary and secondary circuit; and across this bridge, or air-gap, induction is forced as the secondary current increases. This leakage, therefore, diminishes the E.M.F. in the secondary circuit, and that effect tends to keep down the secondary current, and hence to preserve it at a constant value. Such a transformer can therefore be employed to work arc lamps in series off a constant-potential primary circuit. The secondary drop is found to be affected to some degree by the nature of the alternators on which the test was made. A peaked primary E.M.F. curve gives a greater leakage drop than one with a more rounded from. In general, however, magnetic leakage is a thing to be discouraged, and every specification for transformers ought to contain a clause defining and limiting the amount of secondary drop. One convenient way of doing this is as follows: Suppose the standard secondary E.M.F. to be 100 volts and the primary E.M.F. 2,000 volts, then the specification should define that when the transformer is working on a constant-potential primary circuit of 2,000 volts, the secondary terminal potential difference on the transformer should be 100 volts at half load. At full load the secondary potential

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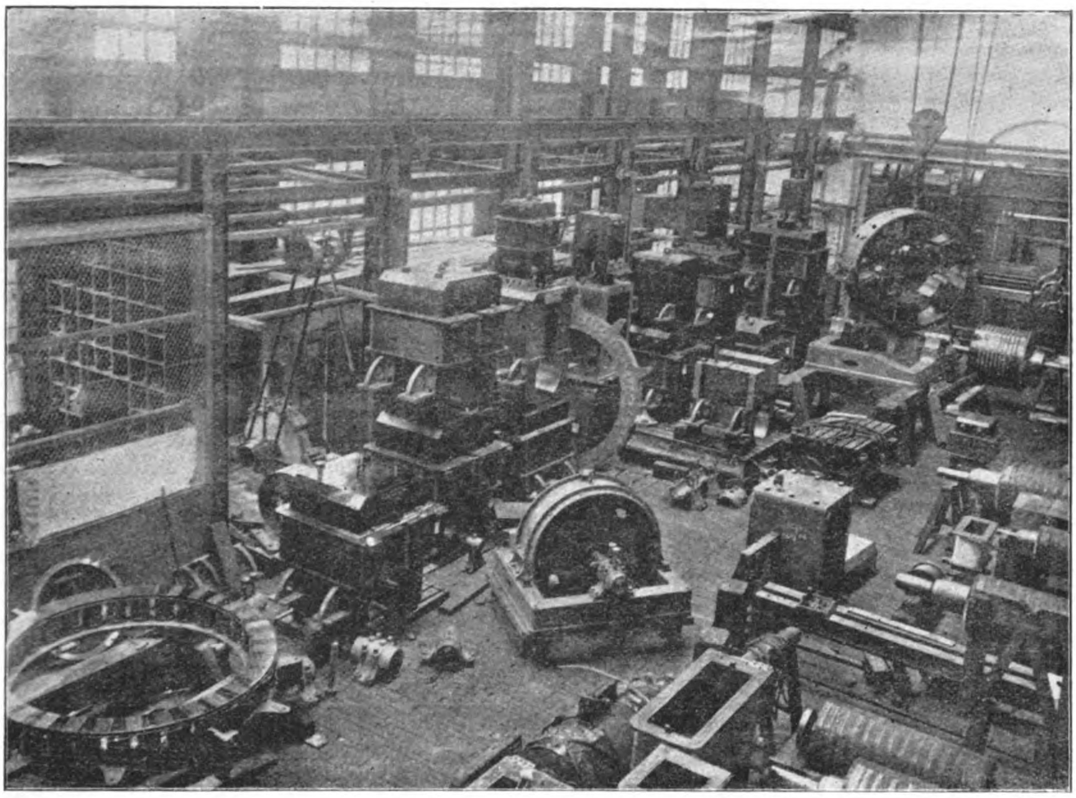
difference should not be less than 98½ volts, and at no load should not be greater than 101½ volts. In this manner the unavoidable secondary drop is, as it were, distributed half up and half down, and is not so much felt on the lamps as if the transformer gave its standard E.M.F. at no load, and then experienced the full effect of the drop when loaded up to full load. Also in a specification for transformers the manufacturer ought never to be allowed to produce a high efficiency at the expense of a large secondary drop, but such a definition of the core loss and copper loss ought to be given that he is bound to produce an all-round excellence. As a sort of guide to the kind of figures which may be obtained by good makers in actual practice, the following table may be taken as representing the secondary drop and core loss in transformers of these various sizes. These figures may be taken as a kind of indication of the core loss and secondary drop, which can be obtained in good modern practice in the construction of transformers. Some makers may be prepared to do better than this; but exceedingly small iron core losses ought always to be looked upon with a certain amount of suspicion, the important question being, not how low can the iron losses be made at first, but how long will they keep low when the transformer is being used; and this, as above stated, can only be determined by careful tests, made at intervals, as the transformer ages.

Size of transformer defined by full secondary output in watts.	Allowable iron core loss on open secondary circuit in watts.	Allowable secondary drop in per cent. of normal secondary E.M.F.
750	20 to 23	3
1,500	36 ,, 41	3
2,250	43 ,, 50	3
3,000	49 ,, 57	3
3,750	62 ,, 71	3
4,500	65 ,, 74	2¾
6,000	75 ,, 87	2
7,500	88 ,, 101	2
9,000	105 ,, 121	2
10,500	115 ,, 133	2
12,000	121 ,, 139	2
13,500	138 ,, 155	2
15,000	150 ,, 172	2

MESSRS. SIEMENS BROS. AND CO.'S ERECTING SHOP.

We have referred several times in our columns to the remarkable number of orders booked by the above firm in the first months of the present year. Both the quantity and the average size of the dynamos ordered were above any previous record of an English firm. We understand that the machines ordered are now all well on towards completion, and as several of the customers are unable to accept delivery the erecting shop of the firm presents a remarkable appearance. We are able to give some idea of this from our illustration, but unfortunately the dimensions of the dynamos and alternators cannot be accurately gauged from it. The usual practice of standing a 5ft. nothing man in the background has not been adopted, but the height of the table of the planing machine will give some idea of the sizes to the workshop engineer. Examples of all the types of electric generators made by Siemens Bros. are included in this view. The circular frame at the left of the illustration is one-half of the magnet field of an alternator of the original Siemens type, which has no iron in its armature. Another type of alternator, with stationary armature and revolving field, is seen in the centre of the foreground. The six large two-pole dynamos on the left, which are piled one above the other, are all from 350-h.p. to 400-h.p. machines, for coupling to high-speed engines. The front machine in the second layer is a 400-h.p. one, and is going to the station of the Charing Cross and Strand Electric Lighting Company. Other two-pole dynamos of



Siemens Bros.' Erecting Shop, August, 1896.

the same output, and some smaller ones, can be seen ranging down that side of the shop. At the further end a six-pole magnet field is shown. This is the first large direct-current multipolar dynamo manufactured by this firm, and it is intended to give about 600 h.p. It is, with its fellows, being supplied to the order of the Bradford Corporation. The armature of this dynamo is placed at the right-hand side of it. It is worthy of note that the above firm, whose two-pole dynamos up to 400 h.p. have gained such an enviable reputation for non-sparking and cool running, have adopted a multipolar design for a large size. We gather from this that the firm recognise a limit to the possibilities with two dynamos, although they set the limit of output much higher than many other designers. It will be interesting to note whether these Bradford machines will not initiate a change in the general practice in favour of multipolar design, on the ground of economy in first cost.

We have always considered that the multipolar machines in England have not had a fair trial, but have been judged by early types with cast-iron fields. The possibilities with the cast steel now available are very different to those in the close of the eighties, and we believe that the record of a few good multipolar machines would do much to turn the favour of the consulting world towards the less expensive types.

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INTERFERENCE.

In our last issue we gave the gist of the answer of the President of the Board of Trade to a question of Mr. Elliott Lees relating to electrical railways. The particular subject of the interference of one electrical undertaking with another electrical undertaking has only been partially discussed and settled, but with the greatly increased number of such undertakings the subject is rapidly becoming ripe to be settled as a whole. The ordinary law of the land is sufficiently complex to tax all the powers of the ablest lawyers who study it all their lives, and is not to be understanded of the multitude. Hence, it is with some fear of being wrong that we venture to say one broad idea seems to underlie all our law, to the effect, as is often said, "possession is nine-tenths of the law." The first comer seems to us to stand legally upon quite a different footing to all followers. So far as electrical matters are concerned, this seems to be the view of those who have hitherto had occasion to investigate matters. Up to the present the most important cases investigated have been in connection with telegraphy and telephony as interfered with by electric light or by electric traction mains. Telegraphic lines and telephonic lines were in operation before the Deptford station was built or the Leeds tramway to Roundhay projected. The Government on the one hand, and the Telephone Company on the other hand, were successful in their contention that the other electrical undertakings interfered with the due working of their undertakings, and the new comers, so far as we recollect, had to take all precautions to prevent such interference. At the time of the Leeds discussion we pointed out that the first comer might be in a far better position to prevent interference from the second, and at a far less cost than the second could be in preventing interference. Let us, however, assume a simple case. The first comer has an open field—he starts some electrical work, no matter of what kind. Naturally, he does his work at the lowest possible cost and without any provision for future interference. Thus, if possible, he will use earth returns and not metallic returns, because the latter, though preferable for many reasons, are more costly, and under certain conditions earth return is perfectly satisfactory. Now, the new comer commences operations—uses heavier or different currents, and also attempts to use earth returns. The result may be disastrous to the first undertaking, but the compulsion upon the second comer to use metallic returns may increase his outlay beyond the point of possible remuneration, or involve him in an expenditure far and away greater than it would the owner of the first undertaking to put his work into such a position that the interference of the second is impossible. According, however, as we read the law and the Board of Trade regulations at present, the first comer has the prescriptive right to the use of earth to the detriment of all future operators. Carry the matter further. Assume that you have installed an electric light undertaking upon the continuous-current system, and that a heavy railway is to

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be run by an electric system—an alternate-current system for preference. Will there be any interference if the first comer has not provided against such a contingency? If there is interference, who is to be at the expense of putting an end to such interference? The Board of Trade have issued regulations which may be satisfactory so far as telegraphy, telephony, and electric lighting are concerned, or so far as telegraphy, telephony, and electric traction are concerned, but as yet there are no regulations which take into consideration the action of traction mains upon electric lighting mains, or *vice versâ*. This seems to have been the point raised by Mr. Elliott Lees and answered by Mr. Ritchie. This answer indicates that the Board of Trade will issue regulations concerning these interferences, and we have to point out to those interested that the time for making representations to the Board of Trade is before these regulations have been issued, and that criticism after their issue will be of little use. In many instances the grumble of the electrical industry at the Board of Trade has not been warranted, in that the members when given their opportunity to direct have failed to take any advantage of that opportunity.

THE APOSTOLOFF AUTOMATIC TELEPHONE.

We were invited on Wednesday last to a Press view of the above-named telephone, or, rather, telephonic system. The invitation was for 3 p.m., but some Government officials who were inspecting the instruments kept Mr. Salomon Berditschewsky, the inventor, from seeing us till considerably after four. As a result the time at our disposal was too short to enable a full grasp of the automatic details to be obtained. The long wait was spent over cigars and in the pleasant company of a commercial official of the company. He had observed a nice distinction between the capabilities of technical experts and commercial men generally which was well worthy of public notice. Thus, after reading the evidence of Mr. W. H. Preece, C.B., on the telephone question at the recent Government enquiry, our entertainer was surprised to see the grasp Mr. Preece had of the subject seeing that he was a technical man. We were also told that the apparatus about to be viewed had been made specially large so that the technical men should understand it, but the commercial form would be either three-eighths the size, or else it was 3·8 times—he was not quite sure which, but anyway, it would be smaller.

The object of the invention devised by Mr. Berditschewsky (called Apostoloff) is to dispense with the use of the telephone operator and to make the subscriber control the cross-connections at the central exchange. In the telephone itself no change is proposed, but some small additional apparatus will be placed on the subscriber's instrument.

The troubles caused by the growth of telephonic exchanges as at present designed have been fully explained of late by Mr. Dane Sinclair in his historical paper before the Institution of Electrical Engineers, and are also referred to in the description of the Naglo-Hess-Raverot-West system now appearing in our columns. The multiplicity of contacts required increases rapidly as the number of subscribers goes up, and the limiting numbers with the present system are within sight. The main principle for reducing the number of contacts underlying this Apostoloff system is somewhat similar to that equipped by Messrs. Naglo and Co. at Berlin, but the principle is carried out farther. Before describing the apparatus we may well summarise the objects it is designed to fulfil.

The automatic system allows each subscriber to personally place himself in direct communication with any other subscriber in the same town without the aid of an exchange employé. It will also enable him to communicate with all the subscribers simultaneously. This last facility appears to us to be a decided objection. The advertising crank would certainly avail himself of the opportunity. The system can be easily extended to interurban work. Although certain cross-connections to other subscribers than the one wanted are at times made in the process of connection as soon as the subscriber wanted is rung up, all metallic connections with the exchange are cut off, and the direct through connections between the two leads and two returns only remain.

In this way there should be absolute secrecy of conversation as far as the exchange is concerned, but the system does not affect the induction trouble. The claim for a saving of time can only be substantiated on trial, but it is noted that while one subscriber is talking no one else can ring him up or interrupt. Also, the new subscriber who fails to ring him up gets no intimation beyond the failure to respond that the line is engaged. In what respect this is preferable to present systems we fail to see. We would call Mr. Berditschewsky's attention to the fact that the great cause of delay at present is not due to defective switching arrangements, but rather to busy firms being served by one telephone only. This telephone is often used for messages from the firm only for a considerable time, and other callers cannot get on. At present you do get the irritating message that Mr. So-and-so is engaged, but with the automatic system you would get no reply whatever, which would not be in any way more assuring.

Coming to the general principles of the mechanism devised to give the above result, we are sorry that time precludes us giving illustrations in this issue. The first point in the development of the automatic gear is to have a revolving contact in the exchange which will, step by step, put the subscriber on to every other subscriber. It will at once be seen that this would necessitate 10,000 contacts to each subscriber in a 10,000-number exchange were the elementary revolving contact to be used. The inventor gets over this difficulty as follows: In the condition of rest all the wires in the exchange are grouped into series of 100 each. There are, of course, two wires—one the lead and one the return—from each subscriber. Consider these arranged in a square block, with 100 wires each side. Then in the cube containing the lead wires one horizontal connection would join up all numbers from 1 to 100, another all wires from 101 to 200, etc. In the cube containing the returns the connecting wires would run vertically. Thus one wire would connect the numbers 1, 101, 201, 301 . . . 9,901; another wire would connect 2, 102, 202, 302 . . . 9,902. Now, with two revolving or sliding contacts, with 100 contact points, any one wire can be signalled out. Thus if the lead from the subscriber is made to the 'bus wire containing the numbers 801 to 900, and the return wire to the wire connecting all numbers ending in 2, the signal will be sent to the subscriber whose number is 802. The lead connections thus gives the first two significant figures in the subscriber's number, and the return the last two. The number of connections required at the exchange for each subscriber is therefore twice the square root of the number of subscribers. This principle is in the final form of the apparatus carried out a second time to still further reduce the number of wires and movements. In finding the subscriber's wires in this way two things are necessary—the first, a revolving contact at the exchange, and, secondly, a synchronously revolving indicator at the subscriber's end. This is effected by a step-by-step movement which cannot be described clearly without illustration. After a conversation the apparatus at both ends of the line return to zero, so that at the start absolute uniformity is ensured. The operation of calling consists first in pressing a button under a small aperture ruling the first two significant figures. Numbers appear at the window in rotation, and the caller presses the button again, when the correct number appears. He then adjusts the two terminal significant figures in a similar way at another window at the other side of the instrument. The number he requires to call will thus be readable on the instrument. The next action is to ring up the subscriber wanted. This effects two essential changes: the individual lines and returns are first

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disconnected by relays from the group wires, and next are directly connected each to each. The two lines and returns are then wholly independent of the exchange. After this the rest of the operations are progressive, and not unlike those in an ordinary exchange. All the time the line wires are thus disconnected from the grouping wires no other subscriber can get on to them.

The general idea governing the system is thus a most excellent one, but the excellency of working depends on a large amount of automatic apparatus. We are assured by the inventor that £3. 3s. will cover the first cost for each subscriber. This may be so, but with automatic gear of the delicacy required the best of workmanship alone must be used, or else the cost of upkeep in skilled labour will be very large. In conclusion, the technical parts are well thought out, but it is a question as to whether the apparatus can be relied on commercially.

THE PRINCIPLES OF ALTERNATE-CURRENT WORKING.*

BY ALFRED HAY, B.Sc.(EDIN.), A.I.E.E.

(Continued from page 92.)

43. We have hitherto supposed that the alternating E.M.F. or current with which we have to deal is a simple sine function of the time. In many practical cases, the shape of the E.M.F. or current curve deviates more or less from the simple sine form. In some cases, such as that represented in Fig. 31, the deviation from the simple sine form is very slight; in others, again, such as that shown in Fig. 3, or the one in Fig. 33, the deviation is considerable. A knowledge of the shape of the E.M.F. wave of any given alternator is of considerable importance. The best shape of E.M.F. wave depends on the kind of work which the alternator has to do. Thus, a wave which would be very suitable for supplying transformers might prove totally unsuitable for supplying arc lamps. There is therefore no such thing as *the* best shape of E.M.F. wave for all purposes; whether a given shape is good or bad, depends on the nature of the supply.

The results which we have already established for simple sine waves may be extended to waves of any shape. For this purpose, however, we must be able to *analyse* any given wave into its *simple harmonic components.*

It may be shown that a periodic function is capable of being split up or analysed into a number of simple har-

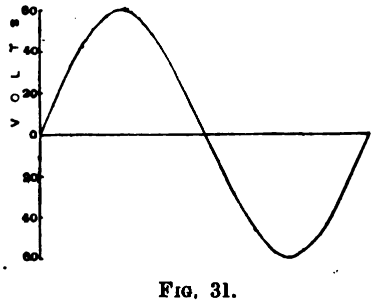

FIG. 31.

monic terms, whose periodicities are whole multiples of the periodicity of the given function. Thus, if n stand for the periodicity—*i.e.*, the number of periods per second—of the function, the periodicities of its simple harmonic components will be n, $2n$, $3n$, $4n$, and so on. If F denote the function, then

$$F = F_1 \sin(pt+\theta_1) + F_2 \sin(2pt+\theta_2) + F_3 \sin(3pt+\theta_3) + \dots$$

where p stands for $2\pi n$.

This expansion of a periodic function in a series of simple harmonic terms is due to Fourier, and is known as Fourier's expansion.

The number of terms in the expansion will depend on the amount by which the function deviates from the simple sine form. In many cases an infinite number of such simple harmonic terms would have to be taken to represent the function with *perfect accuracy.* But in practice the number of terms will depend on the degree of accuracy which it is desired to obtain And just as in calculating the square root of 2, say, we only carry the calculation to as many decimal places as will ensure the required degree of accuracy, so in using Fourier's expansion we take only the first few terms and neglect all the remaining terms. In order to ascertain the degree of accuracy corresponding to a given number of terms, we have merely to reconstruct the function from these terms, and compare the resultant curve with the graph of the given function.

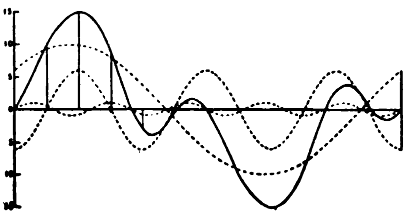

FIG. 32.

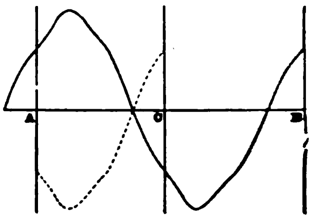

FIG. 33.

The expression given above for the harmonic expansion of a periodic function F may be thrown into a slightly different form. Since, by (8) of Art. 8,

$$F_1 \sin(pt+\theta_1) = F_1 \cos\theta_1 \sin pt + F_1 \sin\theta_1 \cos pt,$$

$$F_2 \sin(pt+\theta_2) = F_2 \cos\theta_2 \sin 2pt + F_2 \sin\theta_2 \cos 2pt, \text{ etc.,}$$

we may, putting $F_1 \cos\theta_1 = A_1$, $F_1 \sin\theta_1 = B_1$; $F_2 \cos\theta_2 = A_2$, $F_2 \sin\theta_2 = B_2$, write the expansion in the form

$$F = A_1 \sin pt + B_1 \cos pt + A_2 \sin 2pt + B_2 \cos 2pt + . \quad (25)$$

44. The E.M.F. curve of an alternator is a *symmetrical curve*—*i.e.*, the negative half-waves are an exact copy, with sign reversed, of the positive half-waves. This at once follows from the fact that the poles of an alternator (whether north-seeking or south-seeking) are all alike. A want of symmetry in the E.M.F. wave could only be produced by giving alternate poles a different shape.

In Fig. 32 is represented a periodic function, along with the simple harmonic terms into which it may be analysed (shown dotted). The sum of the ordinates of the three dotted curves gives us the full-line curve, which is the resultant function. In the present case, the function is represented by the sum of the three terms,

$$10 \sin(pt+\theta_1) + 6 \sin(3pt+\theta_2) + \sin 5pt,$$

where $\tan\theta_1 = \frac{3}{4}$ and $\theta_2 = -\frac{\pi}{2}$.

In Fig. 33 is represented the E.M.F. curve of a certain alternator. Let A and B be any two points the distance

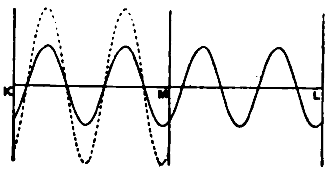

FIG. 34.

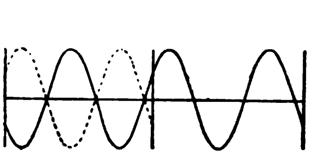

FIG. 35.

between which corresponds to a complete period. Divide A B into two half-periods, A C and C B. If now the portion of the curve included in the second half-period C B be superposed on that included in the first half-period A C, as shown by the dotted curve, it follows from the symmetry of the positive and negative half-periods that the resultant curve has every ordinate equal to zero. The two half-periods, therefore, into which any period of an E.M.F. curve is divided will, when superposed, cancel each other. From this there follows at once the important result that *an alternator E.M.F. curve contains harmonic components of an odd order only, and (so long as it is symmetrical) can contain no harmonic component of an even order.*

To prove this, let us suppose that a certain periodic function contains a harmonic component of an even order. Let this harmonic component be represented by the full-line curve shown in Fig. 34, and let K L correspond to a complete period of the given function. If we divide K L

* Based on a series of evening lectures delivered at the University College, Liverpool.

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into two half-periods K M and M L and superpose them, then, since each half-period contains a whole number of periods (or an *even* number of half-periods) of the harmonic component under consideration, the resultant curve (shown dotted in Fig. 34) will be one whose ordinates are double those of the given harmonic component. Hence no *symmetrical* curve can contain a harmonic component of an even order, for, as we have seen above, the superposition of two half-periods of such a curve gives a resultant all whose ordinates are equal to nothing.

If, on the other hand, a periodic function contains a harmonic component of an *odd* order, as shown in Fig. 35, then the superposition of two half-periods causes that component to vanish, for each half-period of the given function now contains an *odd* number of half-periods of the harmonic component considered.

Having thus shown that an alternator E.M.F. curve contains harmonic components (or *harmonics*) of an odd order only, we need not further consider curves involving even harmonics. A function containing only odd harmonics may be written in the form

$$F = A_1 \sin pt + B_1 \cos pt + A_3 \sin 3pt$$
$$+ B_3 \cos 3pt + A_5 \sin 5pt + B_5 \cos 5pt + \text{etc.}$$

(To be continued.)

DESCRIPTION OF THE ALUMINA FACTORY AT LARNE HARBOUR.*

BY JAMES SUTHERLAND, MANAGER.

Sources of Aluminium.—Aluminium is one of the most abundant metals found in the earth. It is not met with in the metallic state, but its compounds with oxygen, fluorine, the alkalis, silicon, and the acids are so numerous and so widely diffused that it is almost impossible to obtain a portion of the earth's crust in which it will not be found. The compounds of aluminium with silicon and other bases are the most numerous. These in the form of felspar and mica, mixed with quartz, form granite. By the influence of air and water these compounds are decomposed, the alkali is replaced or carried away, and the residues form clays. Such precious stones as the ruby, sapphire, garnet, and cryolite also contain large quantities of the metal; the ruby and sapphire are almost pure oxide or alumina; and cryolite, a double fluoride of aluminium and sodium, is found in abundance, containing 13 per cent. of a luminium. But the clays present the largest source of the metal, and the mineral called bauxite is generally used for its production. Bauxite derives its name from the French town of Beaux, near which it was first discovered. Since that time large deposits have been found in County Antrim, where thousands of tons have been mined during the past 20 years, chiefly for the manufacture of sulphate of alumina and other salts of aluminium.

Analysis of Bauxite.—County Antrim bauxite contains: alumina, 56 per cent., corresponding with aluminium 29·9 per cent.; peroxide of iron, 3; silica, 12; titanic acid, 3; and water, 26 per cent. From this analysis it will be seen that, if the aluminium is to be obtained in a state of purity, the peroxide of iron, silica, and titanic acid must be separated out before the extraction of the metal from the alumina is attempted.

Alumina Factory. — The most convenient method for obtaining pure alumina from bauxite is that discovered by Dr. K. H. Bayer, which is used in the alumina factory at Larne Harbour. The factory is situated close to the terminus of the narrow or 3ft.-gauge line of the Belfast and Northern Counties Railway, whereby it is conveniently connected with the mines at Glenravel, 35 miles distant. The main building of the factory is 240ft. long and 80ft. broad, the loftiest portion being 30ft. high; it is built of brick, and covered with a slated roof on iron principals in two bays of 40ft. span each. Steam at 100lb. pressure per square inch is generated in two Lancashire boilers, 25ft. long and 8ft. diameter, fed by a direct double-acting duplex steam-pump, with pure water at 180deg. F. obtained from the evaporating apparatus. The necessary draught is obtained by a chimney 120ft. high. The driving power required is supplied by a horizontal non-condensing engine, with cylinder 14in. diameter and 20in. stroke, running at 140 revolutions per minute. The slide-valve has an expansion valve on the back, and the cut-off is regulated by a hand-wheel. The engine is capable of exerting 80 h.p. when working against a back pressure of 10lb. This amount of back pressure is due to the exhaust steam assisting in the heating of the evaporating apparatus. The power is transmitted to the main shaft, which runs at 200 revolutions per minute, by four 5½in. cotton ropes driving on the flywheel, which is grooved for the purpose.

Grinding and Calcining.—The trucks of bauxite as received from the mines are run directly into the grinding room. Here the ore is fed into a disintegrator, and ground to ½in. cubes, which fall down a shoot into the bottom boot of an elevator, whereby they are delivered into a riddle of ¼in. mesh. The ore which passes through the mesh descends a sheet-iron pipe into the calciner; while the tailings are returned to the disintegrator by gravitation, to be ground over again. The organic matters present in the ore require to be destroyed, and for this purpose calcination is resorted to. The calcination is important, because the presence of organic matters would retard, if not totally prevent, the subsequent separation of the alumina from the caustic soda in the decomposing cylinders. On the other hand, too great heat would cause the ore to become far less soluble in the solution of caustic soda.

Calciner.—The calciner consists of an iron tube 33ft. long and 3½ft. diameter, lined with firebrick, and mounted on rollers to permit of its revolving. It is inclined at an angle of 1 in 25, and is heated by a furnace at the lower end, from which the heat passes up through the tube and into a chimney at the higher end. As the tube revolves, the bauxite fed into the higher end travels downhill towards the lower end and meets the heat ascending from the furnace, which is regulated to suit the extent of calcination required. On leaving the tube the calcined ore falls upon a plate having a slot in it just large enough to allow the bauxite to pass. Through the slot it descends by a shoot into the cooling tube, which is 30ft long by 2½ft. diameter and also revolves, being inclined in the opposite way to the calciner tube. Here the ore is cooled by a current of air drawn through the tube by a fan connected with the opening. At the outfall of the cooling tube is placed a spiral conveyor, which discharges the ore into a second disintegrator, where it is ground sufficiently fine to pass through a 30 mesh sieve—that is, one with 30 holes per lineal inch, or 900 per square inch. Thence an elevator deposits it in a store having a hopper bottom, underneath which the small trucks can be run to be filled.

Kiers.—The alumina is extracted from the ground bauxite by treating it with a strong solution of caustic soda under pressure. A soluble compound of alumina and soda, called aluminate of soda, is thereby formed, while the peroxide of iron, silica, and titanic acid remain as insoluble compounds. This decomposition is effected in pressure kiers, which are constructed of mild-steel plates ⅝in. thick, and are 11ft. long by 5ft. diameter inside, and surrounded with a steam-jacket for heating. A horizontal 3in. shaft runs through the kier longitudinally, and is fitted with eight 16in. by 9in. paddles, which keep the contents in constant agitation. Stuffing-boxes are fitted at the ends of the kier, for the shaft to run in. Each kier is provided with a charging and a discharging opening, and a safety-valve; and the jacket with steam inlet, safety-valve, and water outlet, the latter being connected with a steam trap. The kiers have been tested to 200lb. per square inch, and are constructed to work at 100lb., although in practice about 80lb. is found to be sufficient for effecting the decomposition of the bauxite.

The necessary supply of caustic soda solution having been run in, usually of 1·45 specific gravity, the agitator is set going, and the bauxite previously weighed is admitted. This is done by a small elevator, which supplies the quantity automatically and regularly, thus ensuring thorough admixture. When the charge is all filled in, usually about three tons, the charging opening is closed, and steam is turned on into the jacket. The pressure is

* Paper read before the Institution of Mechanical Engineers.

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slowly increased up to 70lb. or 80lb., which is maintained for two or three hours until the decomposition is complete. The discharge cock is then opened, and the mass is blown out by the pressure in the kiers up into the red-mud tanks, which are placed in the highest part of the building. Here the mass is diluted with washing water to a specific gravity of 1·23, and is then ready to be filtered in order to separate out the aluminate of soda solution from the impurities.

Filter Presses.—The filter presses used for this purpose each contain 50 chambers, giving cakes 30in. square and 1in. thick. The impurities being insoluble are retained in the press, while the liquid aluminate runs out into the filter tanks. When the press has become filled with red mud, the cakes before being removed from it are subjected to a systematic washing for extracting as much of the aluminate of soda as possible. The washing water is utilised for diluting the mass blown up from the kiers. Centrifugal pumps are employed for charging and washing the presses. Conveyors are placed beneath each filter press, which receive the cakes of red mud when the press is opened and deposit them on trucks placed outside the building. At present the red mud is useless, but experiments are being conducted which it is hoped will result in a profitable use being found for what would otherwise be a troublesome by-product.

Cellulose Filters.—The lyes from the filter presses, collected in the filter tank, are then subjected to another filtering process through cellulose consisting of papermakers' wood pulp. These filters are composed of lead-lined vats with sloping sides, 10ft. long by 6ft. broad and 3ft. deep, with a ledge round the inside 6in. from the bottom, on which is placed a sieve of ⅛in. mesh, supported on a frame. Two of these filters form a set, one placed above the other. About 50lb. of cellulose is boiled with water to a thin pulp, and is run upon the sieve in each filter; it soon settles down and is ready to receive the lyes, from which it retains all the finely-divided insoluble particles that have escaped from the filter presses; the result is a perfectly clean liquid composed of pure aluminate of soda. This final filtration is necessary if the alumina, and consequently the aluminium, is to be produced in a state of purity.

Decomposing Cylinders.—For the separation of the alumina from the soda the decomposition of the aluminate was formerly effected by blowing carbonic acid gas through the liquor, when the soda combined with the carbonic acid, forming carbonate of soda, and the alumina was set free in the form of hydrate of alumina. The carbonate of soda had afterwards to be retransformed by a chemical process into caustic soda before it could again be used for decomposing a fresh charge of bauxite. By the Bayer process the separation of the hydrate of alumina is brought about by the addition of excess of hydrate of alumina itself, and constant stirring in the decomposing cylinders, which are large circular tanks 13ft. diameter and 20ft. high, provided with agitators. In practice the liquid aluminate of soda from the cellulose filters is pumped up into large tanks of 4,800 gallons capacity, placed above the decomposers. The liquor can be measured and heated, if necessary, in the tanks. The decomposer, in which sufficient hydrate of alumina has been allowed to remain for beginning the decomposition, is filled, and the agitation started. In about 36 hours, 70 per cent. of the alumina in combination with the soda has separated out; and this is the extent to which the precipitation usually takes place. The agitator is then stopped, and the contents of the decomposing cylinder are allowed to settle. In a short time the hydrate of alumina settles to the bottom, and the clear liquor is run off the top by gravitation into the weak-liquor tanks.

Hydrate Filter Presses.—After as much as possible of the clear liquor has thus been decanted off, the hydrate of alumina is pumped out of the decomposing cylinder, sufficient being allowed to remain behind in the cylinder for beginning the decomposition of the next charge of liquor admitted. The hydrate of alumina pumped out is filtered through filter presses, and the weak liquor passing through the cloth is allowed to run into the weak-liquor tanks. The charging of the hydrate filter presses is done by a horizontal twin direct-acting steam-pump, with steam-cylinders 7in. diameter, rams 5in. diameter, and 12in. stroke. The pump is provided with an automatic arrangement for shutting off the steam when the presses are full: a ½in. pipe leads from the air-vessel, and when the pressure exceeds 80lb. it raises a weighted diaphragm, which closes a valve placed in the steam-pipe beneath the throttle-valve, and so cuts off the steam.

Washing and Drying.—When the filter presses are full, washing is commenced in order to remove the last traces of soda. The pump for this purpose is duplex direct double-acting, with 5¼in. steam-cylinders, 3½in. pump cylinders, and 5in. stroke. The washing is done systematically, as before, in five different stages, the last of which is with pure water. After washing, compressed air is forced through the cakes to remove as much water as possible. The air-compressor is horizontal, with steam-cylinder 8in. diameter, air-cylinder 6in. diameter, and stroke 14in. It has a suction capacity of 90 cubic feet per minute when running at 120 revolutions per minute and delivering at 80lb. pressure per square inch. The air-compressing cylinders are provided with water-jackets to keep them cool.

Calcining Furnace.—Conveyors are placed beneath the hydrate presses, which deposit the hydrate of alumina on the top of the calcining furnace, where the moisture and water of hydration are driven off. The furnace has a bed 20ft. long and 6ft. wide, and is fired with Dowson gas, for which the generator is placed in a small shed outside the main building, so that no dust may get mixed with the alumina. The products of combustion pass between the arch over the hearth and a drying tray placed above, on which the hydrate gets a preliminary drying before being admitted to the hearth. A low temperature is sufficient to drive off the moisture and the water in chemical combination, leaving the alumina perfectly anhydrous; but if formed in this way it takes up water again readily. To prevent it from doing so, the anhydrous alumina is heated to about 2,000deg. F., when it becomes crystalline, in which state it is not so liable to absorb moisture. It is important to have the alumina as dry as possible, for the presence of water means a corresponding loss of electricity during the subsequent reduction When the calcination is complete, the alumina is drawn into iron barrows and spread on a tiled floor to cool, after which it is ready to be packed in casks.

Evaporator.—The weak soda liquors from the decomposers and hydrate presses, having a specific gravity of only 1·2, are too dilute to dissolve the alumina out of the bauxite, and must, therefore, be concentrated by evaporation up to 1·45 specific gravity. The evaporator is of the triple-effect kind, and is capable of evaporating 33,000 gallons of water in 24 hours. It has independent feed, air, and circulating pumps, and the exhaust steam from these, as well as that from the main driving engine, assists in heating the evaporating pans. The circulating water is discharged into a small concrete tank or pond, whence it is pumped up by a 5in. centrifugal pump to the top of the cooling tower, which is 30ft. long, 20ft. wide, and 25ft. high, and is provided with four trays. During its descent into the pond the water is reduced 40deg. in temperature—namely, from 100deg. down to 60deg. F. The water evaporated from the weak soda liquors being pure, and having a temperature of 180deg. F., is used for washing the hydrate of alumina, and for boiler feeding, etc. It is stored in a lead-lined wooden tank of 6,000 gallons capacity, placed above the decomposers; the supply for the hydrate washing is filtered through a small cellulose filter placed beneath. All the drainage of the factory is collected in a concrete tank placed in the yard, and is pumped back, to be used for washing the red mud, dissolving soda, etc. Any soda, aluminate of soda, or water, which escapes by leakage or otherwise from any of the processes, is thus saved. The pump for this purpose is similar in size and make to the boiler feed-pump; it is placed in the boiler-house, and is arranged to feed the boilers in case of a breakdown of the feed-pump proper.

Electric Lighting.—A 15-unit Taunton dynamo is used for lighting the factory at night by means of 10 arc lamps of 2,000 c.p. each and 100 incandescent lamps of 16 c.p. and 32 c.p. The dynamo is driven by a Robey vertical steam-engine, from which the power is transmitted by

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four cotton ropes of 1in. diameter. The dynamo and engine are self-oiling, and require very little attention.

Extensions.—Provision has been made for extensions, the buildings being capable of containing double the machinery already erected, and the beams and columns are already in position for receiving the additional apparatus which it is hoped an increasing demand will soon render necessary.

PLYMOUTH ELECTRIC LIGHTING.

The following is the report of Mr. John H. Rider, borough electrical engineer, to the chairman and members of the Electric Lighting Committee of the Corporation of Plymouth on the scheme for supplying electricity to the borough of Plymouth for lighting and power purposes:

At the outset I would express my entire agreement with the recommendations contained in the report of your sub-committee in December last—viz., (*a*) that the works should be on the shores of the Cattewater; (*b*) that they should be so designed that the waste heat from the destructor may be utilised if hereafter found desirable or feasible; (*c*) that electricity for traction purposes should be supplied from the same station; (*d*) that the ratepayers would derive a profit from the undertaking.

System Recommended.—After taking into consideration the position of the best available site for the works, the extent of the area proposed to be supplied at present, and the future extensions which must rapidly follow into the residential parts of the borough, I recommend that the alternating-current system be adopted for private lighting, with low pressure distributing mains fed from transformer sub-stations for the main streets, and with high-pressure distribution and separate transformers for the more scattered areas. Low-pressure distributing mains should be at first laid in the following streets viz., Old Town street, Ebrington-street, Ham street Treville street (part of), Bedford-street, Whimple - street, George - street, Cornwall - street, Market-avenue. Frankfort-street (part of), and Union-street. These mains would be fed from transformer sub stations built under the footpaths at approximately the following points—viz., (1) corner of Ebrington-street and Old Town-street; (2) St. Andrew's Cross; (3) corner of Bedford-street and George-street; (4) corner of Guildhall-square and Westwell-street; (5) Clock Tower; (6) corner of Union street and Bath-street. The sub-stations would be supplied by means of high-pressure feeder cables coming direct from the generating station. In addition to the above, I would propose to lay a high-pressure main along Lockyer-street to Citadel-road with a view of supplying the property in the immediate neighbourhood of those streets, to be laid in the same trench and at the same time as the arc lighting cables. I recommend that the distributing mains be of the triple-concentric type, on the three-wire system, protecting with lead sheathing and steel armouring, and laid direct in the ground. Service connections can be readily made on such cables when required, without the necessity of special pavement boxes or covers. These mains would not require enlarging to meet any ordinary future demand in the streets mentioned. The high-pressure feeding mains would be of the concentric type, protected with lead sheathing, and drawn into stoneware conduits. Services would not be taken from these cables, as they would go direct to the transformer sub stations to feed the low-pressure distributors. In laying the stoneware conduits spare "ways" would be provided, so that additional cables could be drawn in at any time without disturbing the surface of the footpaths.

Public Lighting.—For supplying the public arc lamps I recommend that either rectifiers or rotary transformers be used, whereby the alternating current is changed into a current always in one direction This will give the best results for street-lighting, and only one class of generating plant would be required at the works. I recommend that arc lamps should be fixed in the following streets and public places—viz.: Ham-street, 4; Ebrington-street, 4; Market-place, 1; Old Town-street, 6; Bedford-street, 6; George-street, 8; Millbay-road, 6; Union-street, 15; Lockyer-street, 3; Guildhall-square, 2; Westwell-street, 1; Catherine-street, 1; Hoe-promenade, 10; Hoe-slopes, 4; Hoe-park, 1; Osborne-place, 2; total, 74 arc lamps. They would be generally placed on opposite sides of the road, and at 11 p.m. every other lamp would be extinguished. Each arc lamp would give approximately 1,500 c.p. at an angle of about 45deg. from the post. This would be a total illumination of 111,000 c p. The gas lamps displaced in the above streets amount to 123, of sizes varying from 15 c.p. to 100 c p. The total light given by them is about 4,730 c.p. I propose that each arc lamp should be charged for at the rate of £16 per annum, which sum would include all charges for current, cleaning, trimming, repairs, etc. The total cost for the arc lighting would therefore amount to £1,184 per year, with a candle-power of 111 000. The gas lamps displaced by the above are costing £475 per year, with a candle-power of 4,730. While the cost of the arc lighting would therefore be 2½ times the cost of the gas lighting, yet the candle-power obtained would be over 23 times that of gas, or in other words, the light would be about nine times as great for the same money. The comparison would be still more favourable to the electric light if the reduced lighting after 11 p m. were taken into account. While the 123 gas lamps reduce from 4,730 c.p. to 1,845 c.p., the arc lamps reduce from 111,000 c.p. to 55,000 c.p. The arc-lamp mains would consist of twin conductors protected with lead sheathing and steel armouring, and laid direct in the ground. The lamps would be arranged on two or more circuits, and would be carried on cast-iron pillars at a height of about 22ft from the ground. The distance apart of the lamps may be seen from the map. It varies from 40 to 90 yards, the average being about 50 yards.

Electric Traction.—In those streets in which electric traction may be afterwards adopted, the arc lamp-posts could be most conveniently arranged to carry a trolley wire from short bracket arms, thus largely reducing the number of actual posts required. The new tramway route from the Market-place to Prince Rock, *viâ* Ebrington-street, Ham-street, Beaumont-road, Tothill-road, and Embankment-road is an exceedingly favourable one to be first equipped for electric traction. It has a total length of 23,000 yards, and with four running cars a five minutes' service could be maintained. I recommend that the electric lighting department should lay the necessary underground cables, and that current should be sold to the tramway department at an inclusive price of 3½d per unit. The cost of the motorcars, and of the overhead trolley wire, with the posts, or other line equipment, would be borne by the tramway department When posts were used both for the trolley wire and for arc lamps, the cost should be divided between the two departments. I consider that the whole of this line would be best served by the overhead trolley wire, carried from short brackets, and that a swivel trolley arm should be used on the cars. Thus, instead of carrying the trolley wire right out over the centre of the track, necessitating long and heavy bracket arms, the trolley arm on the car would lean over to meet the trolley wire, which would be carried on brackets with comparatively short arms. I consider that with due care in the selection of the design of the posts and bracket arms, the overhead line can be put up so as to offend none, while for commercial success the system has no rival. The overhead system is almost universal in the United States. It is used on the Continent in many of the most important cities—such as Rome, Milan Havre, Brussels Zurich, Geneva, Rouen, Hanover, and Hamburg. It has been adopted at Bristol, Walsall, Coventry, Hartlepool, Dublin, Leeds, and Guernsey in the British Islands. The Glasgow, Birmingham, and Leeds Corporations have just sanctioned its use over their sytems. The Bolton Corporation has recently adopted a report recommending its use. The report of the deputation from the Glasgow Corporation contains the following: "The one great and practically the only serious obj ction urged against the overhead wires is the objection to their appearance. . . . We started our investigations more or less in sympathy with this objection, but we are bound to say that what we have now seen has quite removed from our minds objection to the overhead wires. Where the system is carried out in the most approved manner, we found that the wires give only the very slightest offence to the eye, and that a few hours' familiarity removed the objection entirely." The Lord Mayor of Belfast, in his report, says: "Having regard, therefore, to the fact that all practical objections to the overhead system have been surmounted, and that any exceptions thereto from an æsthetical point of view have been reduced to an almost infinitesimal quantity in the best examples of the overhead system, the deputation feel perfectly confident that they are doing the right thing in recommending that system." Trailer cars could be attached to the motorcar on occasions of heavy traffic, and the working expenses of the line should not exceed 6d. per car mile, with current supplied at 3½d. per unit. The advantages of an electric tramway load to a lighting station are almost too great to express. By the very nature of things, the lighting plant is practically idle during 18 out of the 24 hours. But by serving a tramway system, current can be sold during all the hours of daylight as well as of darkness, and thus the output for a given amount of machinery is enormously increased. It will, of course, be understood that the electric lighting scheme proposed in this report is independent of the exact form of electric traction adopted, and can, if thought expedient, be carried out, leaving open for the further consideration of the Tramways Committee and the Council the question as to the actual system to be used. I know of no town more advantageously situated than Plymouth for making its electricity works a success, even from the beginning, and when the whole of the tramway system is supplied from the same works, the cost of production will have been brought down to an exceedingly low figure

Generating Station.—I consider that the most suitable position for the electricity works is on the site of the Prince Rock cottages. The new Prince Rock approach road leads directly to it, and will form the most direct route for the mains into the town. The station buildings can be placed parallel with the railway, which will lie between them and the Cattewater. A wharf for unloading coal would have to be provided, with a line crossing the existing railway, running direct into the works. At the back of the station buildings is an excellent spot for the destructor work, and arrangements could be readily made at any time to utilise any surplus heat or steam from them. There would be no difficulty in procuring abundance of condensing water at all states of the tide. I recommend that the station buildings should contain at first the following plant—viz., three Lancashire boilers, with mechanical stokers and coal-conveying plant; two direct-coupled steam alternators, each for 200 kilowatts; two direct-coupled steam alternators and dynamos, each for 100 kilowatts; and the necessary switchboards, pumps, condensers and other apparatus. The 100 kilowatt sets would be special combinations which could be used either for (*a*) tramway work alone, (*b*) lighting alone, (*c*) tramway and lighting at the same time, (*d*) a motor-alternator for lighting, by unclutching the engine and driving from the accumulators, or (*e*) a motor-generator for tramway work, by unclutching the engine and driving from one of the other alternators. The

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steam-engines to be of the vertical compound condensing pattern, the smaller ones running at a fairly high speed and the larger ones at a moderate speed. The engines to be of the enclosed type, with lubrication to all bearings under pressure. Provision to be made for erecting an additional boiler and a 300-kilowatt direct-coupled set, without alteration to the buildings, but the buildings to be so arranged that they may be easily extended at any time to meet further demands. I propose to work all auxiliary machinery, such as pumps, mechanical stokers, coal conveyors, etc., by means of electric motors, as being much more economical than by a number of small separate steam-engines. For use in connection with the traction plant, I propose to erect a battery of accumulators at the works. These would be charged during the hours of light load—from midnight to 6 a m —would help to meet the sudden demands for current on starting the tramcars; and would take the whole of the car load if required during a few hours each day, besides having several other incidental advantages and uses. The above plant would give an effective output of 400 kilowatts, leaving 200 kilowatts as spare. This would enable the equivalent of between 7,000 and 8,000 8-c.p. lamps to be supplied at one time (equal to about 12,000 8-c.p. lamps connected), besides the arc lighting and the one section of the tramways.

Capital Outlay.—I estimate the capital outlay necessary to be as follows—viz.:

Site	£400
Buildings, foundations, chimney, siding, and wharf	7,000
Engines, alternators, and dynamos	11,250
Boilers, economisers, piping, condensers, pumps, etc.	4,850
Accumulators, switchboards, testing, instruments, etc.	2,400
Travelling crane, oil tanks, filters, station lighting, and general fittings	1,050
High and low pressure mains, conduits, arc lamp mains and traction mains	9,300
Transformers and sub-stations	1,000
Arc lamps and pillars	1,850
Special apparatus for arc lamps with switch gear	1,300
House meters, etc.	1,000
Engineering charges and contingencies	4,600
Total	£46,000

Or about £76. 12s. per kilowatt installed. I therefore recommend that application be made to the Local Government Board for permission to borrow £46 000 for electricity purposes.

Income.—The annual income will be derived from three sources: (1) the tramways, (2) the public lighting, and (3) the private lighting. The car service on the Prince Rock line may be taken as starting from 7 a.m. to 8 a.m., or on the average at 7 30 a m. and ceasing from 10 20 p.m. to 11.20 p m., or on the average at 10.50 p.m. This gives about 15 hours per day per car. As each car will do six single journeys per hour of 2,300 yards, and four cars will be running, we have 6 × 4 × 2,300 = 55,200 yards, or 31¼ car miles per hour. Taking 313 working days per year, we get 15 hours × 31¼ car miles × 313 days = 146,953 car miles per year. Experience has shown that an electric car will take on the average one B.T. unit per mile to drive it. So that we may reckon on an output of about 147,000 units per year for this one section of the tramways The public lighting, consisting of 74 arc lamps at £16 per annum, will bring in a revenue of £1,184. The lamps will take approximately 83,500 units per annum, and the charge therefore comes out at about 3·43d. per unit. It is difficult to estimate the extent of the private lighting for the first year, but judging by the experience of other towns, it will be safe to reckon on a connection of at least 5,000 8-c.p. lamps at the end of the first winter, and of at least 10,000 8-c.p. lamps at the end of the first complete year. Assuming a connection of only 7,500 lamps, this should bring in a revenue of about £3,000. The annual income may be therefore taken as approximately:

Tramways, 147,000 units at 3½d.	£2,143
Public lighting, 74 lamps at £16	1,184
Private lighting	3,000
Total income	£6,327

This income would rapidly increase with an increasing private connection, and also as other sections of the tramways were converted to electric traction, without a proportionate outlay either on capital or running expenses.

Expenditure.—The annual running charges may be estimated as follows—viz.:

Coal, 2,000 tons at 12s.	£1,200
Waste, water, oil, and sundries	100
Workmen's wages at generating station	900
Lamp trimmers, carbons, and repairs to public lamps	450
Salaries—engineering department	760
Office expenses	75
Repairs and maintenance	180
Rates, taxes, and insurance	150
Total working costs	£3,815

This leaves a profit of (£6,327. less £3,815) £2,512 to pay the interest and sinking fund on £46,000, which will amount to £2,497. It will thus be seen that with a moderate private lamp connection, not only will all working costs be met, but the whole of the annual capital charges will be extinguished. At an early date it should therefore be possible to reduce the charges for current all round—to the tramways, and the public lamps, as well as to the private consumer.

Method of Charging.—Instead of charging the private consumer at an uniform price per unit, with discounts based upon the total quantity used, I strongly advise that the Brighton method of charging should be adopted, which gives a great advantage to those consumers who use their light for long hours. The greater part of the works' cost are incurred through being ready to supply, and after those charges have been met, the actual cost of producing the electricity is very small. It is therefore to the advantage of the department to encourage long-hour customers, and I recommend that the charges should at first be: 8d. per unit for all current supplied to lamps which burn one hour or less per day; 3d. per unit for all current supplied over and above one hour per day. For example, a customer who burned his maximum number of lamps for two hours per day would be charged 8d. per unit for the first hour and 3d. for the second, or an average of 5½d. per unit for the two hours. By the use of an instrument called a "demand indicator," placed in connection with the meter of each consumer, and upon his premises, the proper charges are most readily ascertained. As the works would be in operation throughout the day for working the tramways, I recommend that a continuous 24 hours' service be given from the commencement of the undertaking.

If this scheme meet with your approval I should be instructed to prepare the necessary plans and specifications for the various sections of the work without delay, and to invite tenders for the same, in order that no time may be lost in getting to work.

COMPANIES' MEETINGS AND REPORTS.

CENTRAL LONDON RAILWAY COMPANY.

The ordinary half-yearly general meeting of this Company was held on Tuesday at the Cannon-street Hotel, E.C., Mr. Henry Tennant (the chairman of the Company) presiding.

The **Chairman**, in moving the adoption of the report and accounts, stated that the directors had at that time 904 shareholders on the list, which was an increase on the number they had in June. At that stage of the history of the Central London Railway there was not much to say. It was, however, a great satisfaction to be able to point to the fact that a great beginning in the works of the railway had been made. Possession had been obtained for sites for the stations at Shepherd's Bush, Holland-park, Notting Hill-gate, Westbourne, Marble Arch, Oxford-circus, Tottenham Court-road, British Museum, and Chancery-lane. It had also been considered expedient to enlarge the proposed station in Newgate street, near the Post Office, and there would consequently be some delay in acquiring the additional property in connection therewith. It had been thought wise to secure the property as soon as possible, as it would be much more costly to enlarge the station in years to come At Shepherd's Bush, Chancery-lane, Westbourne, Marble Arch, and the British Museum the work of sinking the shaft had been commenced. With regard to the station at the Marble Arch, a beginning had been made a few days ago. The station which was to be made in the space opposite the Royal Exchange in the centre of the City, had also been commenced, and a start had been made with the subways near Broad-street Station The Great Eastern Railway had approved of the plans by the engineers for the station at Liverpool-street, and it was hoped that an agreement satisfactory to all parties would soon be arrived at. The requisite property for the Newgate Station had not been acquired, although arrangements were in progress. The station site between the Marble Arch and Oxford-circus had not been arranged. It was satisfactory to know that six miles out of a total of 6¼ of the railway had been let. The engineers had reported that great progress had been made all along the line in the ironwork, and for the preparation of the shield. The outlay for the half-year had amounted to £273,812. 14s. 9d., which, added to the amount previously expended, would make a total of £442 098. 0s. 11d. In the general balance-sheet the Chairman said the shareholders might have observed an item of £70,000 put down as "Mansion House Works Deposit Account." He explained that the City authorities were anxious that the work of the station in front of the Exchange and near the Bank should be proceeded with as quickly as possible when once begun. To assure the authorities on that point the directors were required to lay down that deposit, which had been securely invested in Consols, and thus all the difficulties and objections in connection with their taking possession of the site had been removed. The payments made had been so large that it had been found necessary to make a call of £2 per share, payable on September 1 next. Some of the shareholders had desired to pay the calls in full, and since the issue of the report in which the notice was given a large number of applications had been received, though they did not cover any huge amount of money. Most satisfactory progress had been made in all the preliminaries and in the actual work as far as circumstances would permit. The Electric Traction Company had shown a disposition, he was glad to say, to press on with the work as fast as possible.

Lord Colville of Culross seconded the resolution for the report and accounts, and it was carried unanimously.

The meeting was made special to consider resolutions relating to splitting the shares as follows: "(1) That every share in the Company's capital upon which not less than 60 per cent. has been, or shall at any time have been, paid up, and with respect to which the directors shall at any time have received a notice in writing signed by the holder or holders thereof signifying his, her, or their desire that such share should be divided, shall upon receipt

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of such notice as aforesaid be divided into two half-shares, of which one shall be called 'preferred half-share' and the other shall be called 'deferred half share.' (2) That upon every such division 50 per cent. upon the entire share shall be carried to the credit of the deferred half-share (being the whole amount payable thereon), and the residue to the credit of the preferred half-share. (3) That the interest which would, under the powers and provisions in that behalf in the Company's special Acts, from time to time or at any time be paid or payable on any divided share if the same had continued an entire share, shall be applied in payment of interest on the two half-shares in proportion to the amounts credited as paid up on such half-shares respectively. (4) That the dividend which would from time to time be payable on any divided share, if the same had continued an entire share, shall be applied in payment of dividends on the two half-shares in manner following—that is to say, first, in payment of a dividend at the rate of £4 per cent. per annum on the amount for the time being paid up on the preferred half-share, and the remainder, if any, in payment of dividend on the deferred half-share, but so that no greater amount of dividend shall be paid on the two half shares than would from time to time have been payable on the entire share if the same had not been divided. (5) That the directors be, and are hereby, authorised to do all acts and things necessary for giving effect to the foregoing resolutions."

The **Chairman**, in reference to this, said that these resolutions, if passed, could be acted upon on the authority of their Railway Act of 1891. In the schemes submitted for the division of stock some shareholders had thought that the directors wanted to increase the nominal amount of capital. In that proposal it was not intended to increase the nominal capital at all. What they intended was, he thought, explicitly explained in the resolutions. The option of dividing the shares was left entirely in the hands of the shareholders.

The resolutions were seconded by **Lord Rathmore**, and carried unanimously.

LIVERPOOL OVERHEAD RAILWAY COMPANY.

The ordinary half-yearly general meeting of this Company was held at Liverpool on Tuesday, Sir William B. Forwood (chairman) presiding.

The **Chairman**, in moving the adoption of the reports and accounts, said he might fairly claim them to be satisfactory. They showed that the traffic on the overhead railway was making steady progress, that the line was being more largely used by the commercial community of the port, and that it was extensively patronised by visitors and sightseers. During the past year they had earned £31,286, and had expended £19,694, leaving a profit of £11,592. Out of this sum they had paid £2,500 as interest upon their debenture bonds, leaving a balance of £9,092, which added to the balance of £2,074 brought forward, gave them a total sum of £11,166 to deal with. The directors proposed to pay 5 per cent. preference dividends, which would absorb £2,700, and a dividend of 2¾ per cent. on the ordinary shares, which would take £5,568. They would thus be enabled to carry forward £2,897. At the same period last year they paid a dividend of 2¼ per cent and carried forward a balance of £1,302. Some directors might think the present balance carried forward rather too large, but if they were able, as they now hoped, to pay a dividend of 3 per cent. next year, they would have to make an additional contribution to the tramway company, and they thought it judicious to make provision for that extra expenditure. Their receipts had increased by £3,154 as compared with the corresponding half of last year, and their expenses in the same period had increased to the extent of £1 141. Of that sum £400 represented rates, an item over which they had no control and which, he regretted to say, seemed to be increasing year by year. The extra revenue of £3,154 had thus been earned with an additional expenditure upon the lines of £600. The average receipts per passenger during the half-year had been 1·96d., against 1·92d. in the corresponding half-year of 1895 whilst their revenue per train mile had been 15·10d., against 14 38d. He regarded these items as exceedingly gratifying. They had incurred an additional expenditure of £485 upon repairs to structure and opening bridges, and of £240 upon stations, but this represented almost entirely the cost of extra painting. They had now got the structure in a splendid state of preservation, and they trusted that in a year or two they would be able to relax their expenditure somewhat upon this item. They were using their electric power for the purposes of painting. The outside of the structure was being painted by means of a machine which put on the paint with a spray, and the machine was worked from their electric conductor on the railway. In this way the cost of labour was reduced nearly one-half—in other words, from 20s. to 11s. 6d. They were also putting £175 more towards their renewal fund, which now amounted to the very satisfactory sum of £5,700. The cost of their locomotive power per train mile had been 3·40d. against 3·49d. last year. He regretted to say that the progress of the works at the south end had been somewhat delayed. They had had a difficult piece of construction in connection with the Cheshire Lines Railway. They crossed the Cheshire lines in tunnel, and the necessary works to make it an efficient crossing had been more difficult than was at first contemplated. It had also been found necessary to construct their bridge with one span instead of two, and this had led to further delay, but he was glad to say that the difficulties were being rapidly overcome, and there was no doubt that the additional works would be open for traffic on November 1.

Mr. Richard Hobson seconded the motion.

Mr. Okell enquired how long the directors proposed to continue their payment of £1,000 per annum to the tramway company.

The **Chairman** replied that the agreement with the tramway company was on a sort of sliding scale. They paid the company £1,000, but they also made additional payments according to the amount of their dividends.

Mr. S. Stitt pressed for further information on the matter, enquiring in what way the overhead railway company benefited by the arrangement.

The **Chairman** stated that during the first two or three years of their existence they encountered fierce opposition from the tramway company, who ran a line of omnibuses from one end of the dock lines to the other every five minutes, and carried passengers at a penny apiece. They suffered considerable injury in this way, and ultimately arrangements were made for the discontinuance of this opposition on an annual payment of £1,000, with an understanding as to additional payments as the dividends increased. The tramway company undertook in addition to run certain lines of omnibuses as feeders to the overhead lines, and to place themselves entirely at the Company's disposal in the event of their ever being threatened with opposition. The directors had under contemplation the desirability of approaching the tramway company to obtain some modification of the terms. They could bring the agreement to a close on a six months' notice given by either side, but they did not think that judicious.

The motion was then approved, and the dividend of 5 per cent. on the preference and 2¾ per cent. on the ordinary shares was passed.

MANCHESTER EDISWAN COMPANY.

The annual meeting of the Manchester Edison Swan Company, Limited, was held last week at the rooms of the Manchester Society of Chartered Accountants, 65, King-street.

In the directors' report, submitted by the secretary (Mr. J. E Sharples), it was stated that the net profit, including last year's balance, amounted to £2,041. 18s. 1d. Out of this it was proposed to pay a dividend at the rate of 5 per cent. per annum, which will absorb £1 500, and to carry forward the balance, amounting to £541. 18s. 1d.

Mr. V. K. Armitage (chairman), in moving the adoption of the report, referred to the competition, not only keen but unscrupulous, to which the Company was subjected by its rivals in its efforts to obtain business.

Mr. W. P. James Fawcus, in seconding the motion, explained that the electric installation at Altrincham, on which there was last year a loss of £400, had now begun to pay. The number of customers was steadily increasing. The Altrincham Electric Supply, Limited, had also got a provisional order for supplying the electric light to Ashton-on-Mersey, and in all probability a beginning would be made with the laying of the mains within the next month or two. At a comparatively small outlay they would thus be enabled to tap another populous district and to increase the profits of the company.

The report was unanimously adopted, and the dividend recommended by the directors was passed. Thanks were accorded to the directors for their services, and a sum of £250 was voted to them.

CHILI TELEPHONE COMPANY, LIMITED.

The ordinary general meeting of this Company was held last Friday at Winchester House, E.C., Mr. George Keith, chairman, presiding.

The **Chairman**, in moving the adoption of the report, said the business of the Company had made considerable progress during the past year. The gross revenue had been 619,826dol., an increase of over 11 per cent. on the previous year, and the number of subscribers had increased by 237. On the other hand, the general expenses showed a marked reduction. The net profit for the year was £8 551, as against £6,013 in the previous year, an increase of £2,538. It was proposed to pay a dividend of 4 per cent. per annum. During the year the Company's property had been considerably improved and extended, a number of rural lines having been added, and, with the exception of some of the older lines, the property throughout was in good condition. The settlement arrived at between Chili and the Argentina had done much to restore confidence, and the course of events seemed tending towards a revival of business, from which the Company would necessarily derive benefit.

The report was adopted.

ALUMINIUM COMPANY, LIMITED.

The ninth ordinary general meeting of this Company was held on Friday last at the Cannon-street Hotel, E.C., Sir Henry E. Roscoe presiding.

The **Chairman**, in moving the adoption of the report, said although Mr. Gerald Balfour, M.P., had felt compelled to resign the chairmanship of the Board, he had consented to continue as a director. The ordinary business at Oldbury had resulted satisfactorily, and the profits had exceeded those of the preceding year, but it was to the sales of patents, for which the Company was indebted to the inventive genius of Mr. H. Y. Castner, that they owed £33,523 out of their total realised profits of £50,681. But beyond this they had shares of the nominal value of £119,000, which he thought was no more than their actual market value. Their net profit for the year, including amount brought forward, was £40,079. After careful consideration, the directors decided upon recommending a dividend of 15 per cent., writing £10,000 off works and a like sum off patents,

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carrying forward £11,079. This of itself secured a future dividend and put the Company in a secure position. Their £12,000 10 per cent. B debentures had been paid off, and their £100,000 6 per cent. debentures would be liquidated in October, partly by the issue of £90,000 4½ per cent. first mortgage debenture stock, thus reducing the debenture debt by £21,800 and saving £3,363 a year in interest. Their revenue would further be augmented in future by dividends on their holding in the Castner-Kellner Alkali Company, besides which they would receive a fixed royalty of £4,000 a year from the Mathieson Alkali Company, which was erecting large works at Niagara Falls for the manufacture of caustic soda. They also held a large interest in the Niagara Electro-Chemical Company, which should yield a good profit, as the works erected by that company at Niagara Falls were now practically finished, and would be started this month. The Aluminium Company held 27 per cent. of the capital of the American company, which for various reasons was nominally only fixed at £20,000, so that the figure £5,400 in the balance sheet did not represent anything like the value of their proportion of that company's property—*i.e.*, that the shares represented by £5,400 were at the present time worth more than that amount. It had lately come to the knowledge of the Board that the Company's sodium patents were being infringed in Germany, and proceedings had been instituted to stop the manufacture. There was every reason to believe that those proceedings would succeed, in which case the Oldbury business would be much increased, and consequently profits also. Patent lawsuits in Germany were, fortunately, not so expensive as in this country. Negotiations referred to last year respecting British and Continental patents corresponding to those sold to the Niagara Electro-Chemical Company were likely soon to be brought to a satisfactory issue.

Sir Andrew Clarke seconded the resolution.

The **Chairman**, in reply to questions by Mr. Dyer, said the B shares were held chiefly by the directors and their friends The suggestion that a settlement and a quotation on the Stock Exchange should be applied for was being attended to by the directors.

The motion was then agreed to unanimously.

A dividend of 15 per cent. was then declared, payable on the 15th inst , and

On the motion of **Sir Andrew Clarke**, seconded by **Mr. Castner**, the retiring directors (Mr. John S. Parkin and Sir Henry E. Roscoe) were re-elected.

IMPERIAL TRAMWAYS COMPANY, LIMITED.

The ordinary general meeting of this Company was held at Bristol last Saturday, Mr. Geo. White presiding.

The **Chairman**, in moving the adoption of the report, an abstract of which has already been given in these columns, said the prospects of the Middlesbrough tramways' undertaking were improving, and at Reading there were evidences of development, the profit there being sufficient to pay 6¾ per cent. upon the Reading share capital. Extra expenditure had. however, been incurred in order to meet omnibus opposition. He then referred to the history of the Dublin Southern Tramways. The question of the loss of the parliamentary Bill need not occupy attention now. Having opened the electric tramway and worked it for a few weeks they were able to demonstrate that their opinion as to the value of the property was a correct one, and the British Thomson-Houston Company, who owned the preference and debenture capital, agreed to purchase the whole of the ordinary share capital which the Imperial Company owned for £130,000 subject to the payment by the Imperial Company of certain liabilities of the Dublin Southern Tramways Company. The Thomson-Houston, on their part, had been able to sell practically the whole concern to the Dublin United at a sufficient sum to cover their outlay and the purchase price paid to the Imperial—a very satisfactory deal, he thought, all round. It was true the Dublin United had had opportunities of purchasing the Southern lines, and the late chairman told him he offered the whole of their interest in the Southern to the United for £20,000. All along the Imperial Company had kept the purpose in view of showing the public and experts in Dublin that the Southern undertaking was all they claimed for it, and in the end they had every reason to be satisfied. Although the United had paid what some people would consider a high price, they had acquired valuable property without paying too dearly for it, seeing the amount of anxious work and ability put into the concern to bring it to the present state by the managing director, Mr. Robinson. The Imperial Company's accounts showed they had received £30,000 on account of the purchase price, and the balance was payable at the end of the present half-year. Between now and February next they hoped to suggest some mode of dealing with the money so received, especially as their position would be somewhat affected by whether or not they disposed of one of their undertakings about which they were now in negotiation. However, it was satisfactory to know that instead of the Dublin ordinary shares they would possess golden sovereigns to the extent of the total share capital of the Imperial Company, and it would be time enough when they were banked to settle the disposition of the money. Any shareholder anxious to anticipate that end could readily sell out at par, £6, rather a different price from three or four years ago, when shares were unsaleable at 15s. The gross revenue, omitting all credit on Dublin account, amounted to a sum sufficient to pay debenture interest and preference dividend at the rate of 6 per cent. and dividend on ordinaries at 2½ per cent., carrying forward a small amount to the new account.

The report was adopted.

CONTRACTS FOR ELECTRICAL SUPPLIES

CONTRACTS OPEN.

Oldham.—The Corporation want tenders by 18th inst. for an electric feed-pump. Particulars from Mr. Andrew, Gas and Water Offices, Oldham.

Nava del Rey (Spain).—The Municipality are open to receive tenders up to August 28 for the electric lighting of Nava del Rey for a period of 20 years.

Bucharest.—Tenders are wanted by August 19 for the electric lighting of the Boulevard Coltea. Application should be made to the Mairie, at Bucharest.

Dortmund (Germany).—The Municipal Authorities of Dortmund want tenders by September 1 for engines, boilers, and dynamos for the electric lighting of the town.

Cassel (Germany).—Tenders are wanted by the Slaughter-house Committee for an electric lighting installation of 80 incandescent and 14 arc lamps. The date is August 15.

Vich (Spain).—The contract will be allotted by the municipal authorities of Vich on August 17 for the electric lighting of the town for 10 years from June, 1897. The annual payment proposed is about £800.

Spa (Belgium) —The Burgomaster and Echevins of Spa invite propositions for undertaking the public lighting, either electrically or by acetylene. The date fixed is September 15. No further information is given in the official advertisement.

Copenhagen.—Tenders are wanted for the supply of 20,000 incandescent electric lamps. Application should be made to Directeuren for Kjöbenhavens Belysningsväsen, Gothersgade, 30, Copenhagen, and tenders must be in by August 22

The Hague.—Tenders are wanted by August 24 for the supply to the Dutch Government of iron telegraph posts, galvanised iron wire (telegraphic insulator pins, etc. Application should be made to the Dutch Colonial Ministry at the Hague.

St. Pancras.—Tenders are wanted for the supply and erection of 80 arc lamp columns about 19ft. high, for the St. Pancras Vestry. Particulars are obtainable at the Vestry's Electric Department Offices, 57, Pratt-street, Camden Town, N.W., and tenders must be in by August 24.

Villefranche-Lauragais (France).—The Municipality of Villefranche-Lauragais (Haute-Garonne) have invited competitive plans for a public water supply and electric lighting. Prizes of 1,000fr., 500fr., and 200fr. are offered, under the usual conditions, and schemes must be sent to the Mairie by October 10.

Dundee.—The Gas Commissioners invite tenders for the supply of indiarubber-covered cables for electric lighting in the Overgate, Wellgate, and Whitehall-street districts of the city. Particulars as to quantities, etc., can be had from the Electrical Engineer, Dudhope-crescent-road, Dundee. Tenders to the Clerk of the Commissioners, City Chambers, Dundee, by 19th inst.

Simla (India).—The Municipality is inviting tenders for lighting by electric light for a term of years the principal thoroughfares and buildings belonging to the Municipality. Tenders must be submitted by September 1 next. Should any proposal be accepted, the Municipality will afford the successful tenderer all facilities to extend the system of lighting to private houses.

Cologne.—Tenders are required by the Municipal Authorities for the construction and working of electric tramways in the city of Cologne to an aggregate length of 20·3 kilometres (12½ miles). Specifications, plans, and particulars are obtainable for 10 marks (10s.) from der Registrateur B, des Oberbürgermeisteramt, Köln, Germany, and tenders must be in by November 6.

Madras.—Tenders are invited for the lighting by electricity of Government House, Madras, including the banqueting-hall and aide-de-camps' bungalow, and also for the lighting of Government House, Guindy, including the military secretary's bungalow. For particulars application must be made to the consulting architect to the Government, Chepank, Madras. Tenders will be opened on November 11, 1896.

Radcliffe.—The District Council invite tenders for the supply and erection of a gas-engine and dynamo and the fitting up and lighting of the Technical School by electricity. A copy of the plans, sections, and specifications may be obtained on payment of 10s. 6d., and forms of tender obtained from the Surveyor, Council Offices, Radcliffe. Sealed and endorsed tenders to be sent to Mr. J. Sharples, clerk by 17th inst.

Voghera (Italy).—In view of the expiration of their contract with the local gas company in 1898, the municipal authorities of Voghera are desirous of receiving during the present year propositions for the lighting of the town either by the electric light or a mixed system of gas and electricity. The population is 16,000. Application should be made to L'Administrazione Comunale, Voghera, who will give all particulars necessary.

Mayaguez (Puerto Rico).—The Secretary of State for Foreign Affairs has been informed by H.M. Ambassador at Madrid that the Spanish Government have invited tenders for the construction and working of a telephone system in Mayagüez, Puerto Rico. The date fixed for the consideration of tenders is October 8, and such particulars as have been received may be inspected at the Commercial Department of the Foreign Office between the hours of 11 and 6 daily.

Dewsbury.—Tenders are invited by the Governors for the wiring and fitting of the Dewsbury and District Technical School. Copies of specifications may be obtained from the Secretary on

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payment of £1. 1s., which will be refunded on return of same, accompanied by a bona fide tender. Plans may be seen at the office of the Secretary, from whom any further information can be obtained. Sealed tenders must be sent to Mr. P. F. Lee, secretary, endorsed "Electric Lighting," by 22nd inst.

Mexico.—The municipal authorities of the city of Mexico are prepared to receive proposals for the street lighting by incandescent lamps for a period of eight years. Tenders should be sent in by August 31. The Secretary of State for Foreign Affairs has received from the British Consul at Mexico a pamphlet issued by the Municipal Council of the city containing particulars as to the tenders, and this may be seen on application to the Commercial Department of the Foreign Office between the hours of 11 and 6. The plan as laid out accounts for 480 arc lamps of 2,000 c.p. each, and 120 of 1 200 c p., to which are added 150 incandescent lamps.

Southampton.—The Harbour Board invite tenders for the construction and erection of four electric cranes and accessories, and also for alterations to a gantry of an existing crane, on the Town Quay, Southampton. Specification, with two general drawings attached, may be obtained on and after 20th inst. from Mr. A. H Skelton, clerk, Town Quay, Southampton, upon payment of £3. 3s., which will not be returned, and further detailed plans may be seen at the office of the electrical engineer, Mr. J. G. W. Aldridge, 9, Victoria-street, Westminster, S.W. Sealed tenders, marked "Tenders for Electric Cranes," should be sent to the clerk by August 31.

Jassy.—The Mayoralty of the Town of Jassy (Roumania) has given notice that on August 23, 1896, old style (by our reckoning September 4), tenders will be received, for the second time, in the hall of the Municipal Council, for "the installation of a frigorific hall, electric light, and various accessories requisite for new public slaughter-houses. Offers must be in accordance with the specification, the conditions of contract, the special conditions, and the plans deposited in the offices of the director of the slaughter-house works, where particulars may be obtained." Tenders are to be enclosed in sealed envelopes, marked "Offre pour l'installation de la Hall Frigorifique," and senders of tenders must abide by articles 68-79 of the Roumanian Public Accounts Act. All tenders and supplementary documents must be in either the Roumanian or French language.

Bath.—The Corporation invite tenders for the supply and erection of the following plant:—Section A: Boiler and fittings, feed pump, etc. Section B: Steam alternators, oil-filter, fittings, etc., steam, exhaust, feed, blow-off, and sundry pipes, valves, etc. Section C: Mains. Section D: Crane. Section E: Arc lamps and posts. Tenderers are at liberty to tender for either section, but not for part of a section. The ground plan of plant and specification, with terms and conditions of tender and contract, may be obtained at the office of Mr. Robert Hammond, the consulting engineer, Ormond House, Great Trinity-lane, E.C., on and after the 13th inst., on payment of £2. 2s., which will be returned on receipt of a bona fide tender. Sealed tenders, marked "Tender for Electric Lighting," must be addressed to Mr. F. H. Moger, clerk, 3, Wood-street, Bath, and delivered by the 31st inst.

RESULTS OF TENDERS.

Hapton (Lancs.).—The tender of Messrs. Simpson Bros., Hapton, has been accepted for lighting the township with electricity from September 1, 1896, to April 30, 1897, at £124.

Cheltenham.—The electrical engineer has reported to the Town Council that tenders for the 15-kilowatt steam-exciter had been received as follows:

	Price with engine— Universal.	Belliss.
Siemens Bros. and Co., Limited...	£399 0 0	£348 0 0
Brush Electrical Engineering Company, Limited	347 5 0	—
Electrical Construction Corporation, Limited	333 0 0	386 0 0
Thomas Parker, Limited	—	329 0 0
	Crompton-Brush	Crompton-Bellis
Crompton and Co., Limited	335 0 0	379 0 0
Mather and Platt, Limited	(with unnamed engine)	425 0 0

It was resolved that the tender of Messrs. Siemens Bros. and Co. for the steam-exciter be accepted, the type of engine to be decided upon later on.

BUSINESS NOTES.

Great Northern Telegraph Company.—For the month of July the receipts were £24,000.

Aberdeen.—There is to be electric lighting at the Aberdeen flower show in the college grounds.

Llanelly.—The Town Council have agreed to an application of the National Telephone Company to erect poles.

Bolton.—The Town Council are endeavouring to get some system of mechanical traction adopted on the tramways.

New Address.—The Universal Electrical Fittings Company, Limited, have removed from Carver-street to Suffolk-road, Sheffield.

Copper.—It is stated that the statistical position of copper continues to be favourable to a further advance in the price of the metal.

Bournemouth.—The Town Council have adopted a resolution that the surveyor should be instructed to report on the telephone arrangements of the Council with a view to obtaining a reduction in the cost.

Ayr.—The report of the Hall Committee which dealt with the electric lighting of the town hall stage has been passed after some discussion.

Electric Construction Company, Limited.—The transfer books for the ordinary and preference shares will be closed from August 13 to 27 inclusive.

Fulham (London).—The Vestry have rejected a proposition to spend £75 to enable a committee to visit electric lighting works and dust destructors.

Western and Brazilian Telegraph Company.—For the week ending August 7 the receipts, after deducting 17 per cent., payable to the London Platino-Brazilian Telegraph Company, were £2,711.

City and South London Railway Bill.—The Extensions Bill of the City and South London Railway Company has passed the Lords, but the Commons reinserted an amendment to preserve St. Mary's Church.

Hull.—At the meeting of the Town Council a recommendation of the Electric Light Committee to put down a new station at a cost of £42,000 for the purpose of extending the electric lighting was lost by 26 votes to 23.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending August 9 amounted to £1,700, as compared with £1,578 in the corresponding week of the previous year, being an increase of £122.

Accident.—Last Friday a floor collapsed at the Anchor Works, Playhouse-yard, St. Luke's, which works are occupied by the London Electric Wire Company, and two workmen named Edwards and Reynolds were injured.

Bath.—In order to perfect the acquisition of the electric lighting works by the Bath Town Council, at a meeting of the shareholders of the electric light company the formal contract has been submitted, approved, and signed.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ending August 7 were £3,210. 3s. 4d., compared with £2,212. 15s. 4d. for the corresponding period of last year, being an increase of £997. 8s.

Colchester.—The Electric Light Works Committee have reported that they had received 10 applications for the temporary appointment of canvasser, and, after interviewing two selected candidates, they had appointed Mr. J. A. Kuner at £2 per week.

Taunton.—The electrical engineer (Mr. H. W. Couzens) reported at the Town Council meeting that there had been a very satisfactory increase in the lamp connections in the borough—92 lamps of 16 c.p. having been installed, and a further 84 applied for.

Eccles (Lancs.).—The Town Council have confirmed the report of the Town Hall and Electric Lighting Committee, and ordered that the seal of the borough be affixed to an agreement with Mr. Cornelius Bagot, on the subject of the town hall extension scheme.

Sheffield.—The Corporation having taken over the tramways propose considerable extensions, and are about to send a deputation to visit various lines in the United Kingdom and on the Continent, with a view to decide on the system of traction to be adopted.

Johnson and Phillips.—Messrs. Johnson and Phillips, of 14, Union-court, E.C., have written to us as follows: "We beg to inform you that Mr. Bennett Pell and Mr. James Brockie are no longer members of our staff, and shall be glad if you will announce the fact in your journal."

Electric Colliery Working.—The Youghiogheny River Coal Company, which own a large property in Pennsylvania, consisting of a number of mines, have lately put down an electrical plant, and are now doing practically all the mechanical work in five of their mines by electricity.

Ipswich.—The Electric Lighting Committee have submitted to the Town Council a long report and reports of Prof. Kennedy on proposals to light defined areas by means of electricity, but the consideration of the reports was postponed until the next meeting of the Council on October 14.

Epsom.—The Urban District Council have agreed to apply to the Board of Trade for a provisional order empowering them to provide electric light if they think fit, but its adoption is by no means decided on at present, and the Lighting Committee will be asked to report on the matter.

Bexhill.—The Urban District Council have received a letter from an electric lighting company in London asking whether the Council intended to apply for a provisional order for general or public lighting only. After a short discussion the matter was referred to the Lighting Committee.

City and South London Railway.—The returns for the week ended August 9 were £895, compared with £860 for the corresponding period of last year, being an increase of £35. The total receipts for the half-year 1896 were £5,419, compared with £5,084 last year, being an increase of £335.

Carbide Syndicate, Limited.—This is a new company, registered, with a capital of £1,200 in £10 shares, to acquire a patent for the manufacture of carbide of calcium, and to manufacture, sell, import, export, and deal in pharmaceutical, medicinal, chemical, industrial, or other preparations.

Leeds.—Through the kindness of the inhabitants of Roundhay and district, the workpeople who have been employed by the Thomson-Houston Electric Car Company on the Roundhay Park tramway have had an excursion to Scarborough. A handsome timepiece, subscribed for by the workpeople, has been presented to Mr. J. Burbridge, the manager of the tramway.

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Morecambe.—The Urban District Council have resolved that application be made to the Board of Trade for consent to the purchase and transfer to the Council of the powers and property of the Morecambe Electric Light and Power Company, Limited, in accordance with an agreement dated February 10, 1896

St. James's (London).—The St. James's Vestry have decided to pay the electric lighting company £30 per lamp per annum for street-lighting for a term of seven years, 21 years being the term asked for by the company. It was stated that the price paid was 40 per cent. lower than that paid by the ordinary consumer.

Jandus Arc Lamp.—Messrs. Drake and Gorham inform us and it may interest our readers to know, that owing to the demand for a small Jandus arc lamp, consuming about two amperes at 100 volts, such a lamp has been designed, and can be seen at any time by calling at 66, Victoria-street, Westminster, S.W. The height of the lamp is 2ft. and diameter of globe 7in.

The Tavernier Motor.—Under the title of the Tavernier Safety Motor Syndicate, Limited, a company has been registered, with a capital of £3,000 in £50 shares, to enter into an agreement with A. E Tavernier. and to carry on business as cycle and carriage manufacturers and dealers, electricians, mechanical engineers. The directors are H. T. D. Sweet, A. E Tavernier, and G. W. Fardell.

Romford.—Messrs. Ind, Coope, and Co have written to the Urban District Council saying that they had been for some time in correspondence with the National Telephone Company, Limited, with a view of obtaining telephonic communication with London, but the matter seemed now to have become quite blocked. It was decided to reply that the Council would be willing to give all the assistance in their power.

Newton Electrical Works, Limited.—This is a company registered, with a capital of £30,000 in £10 shares, in order to enter into two agreements with F. M. Newton to acquire the undertaking of the Newton Electrical Engineering Works as now carried on at Taunton, Somersetshire, The directors are F. M. Newton, H N. Hickley, and L. C. H. Palairet, and the registered offices at Herbert-street, Rowbarton, Taunton.

Waterloo and Seaforth (Liverpool).—The Urban District Council have adopted the report of the Parliamentary Committee, which set forth that a plan of a piece of land situate on the west side of Brighton-road, Waterloo, between King-street and Sandon-street, having been submitted by the Liverpool District Lighting Company as the site of a proposed generating station, it was resolved that such site be approved.

The Amazon Cable.—The Aberdeen sailing clipper "Inverness," which belonged to Messrs. Richardson, Swansea, but which has been lying in Aberdeen Harbour for several months, has been sold to the Amazon Submarine Telegraph Company, and has left for London to be fitted with the necessary appliances for taking in store a cable for the River Amazon, where it is understood she will be ultimately stationed as a storeship.

Sunderland.—The Town Council have discussed an instruction to the Tramways Committee to take into consideration the desirability of the Corporation purchasing the lines of the Sunderland Tramway Company. No conclusion was arrived at. Meanwhile the company have commissioned Mr. R. P. Wilson, of 3, Prince's-mansions, Victoria-street, S. W., to prepare a report on the subject of adapting the lines for electric traction.

Northwich.—The River Weaver Trustees are negotiating for the borrowing of a large sum of money for improvements to the waterway, and something like £30,000 will be expended on two swingbridges, which will probably be worked by electricity. One of these bridges is in substitution of the present fixed town bridge at Northwich, which has subsided so rapidly of late that the salt craft have to be overladen to permit them to pass beneath.

Hastings.—The Roads Committee having received from the secretary of the Hastings and St. Leonards-on-Sea Electric Light Company, Limited, notice of the intention of the company to construct a transformer pit under the public pavement at Claremont, opposite the Claremont Library recommended that the plan be not approved, the site of the proposed pit being, in the committee's opinion, an unsuitable one, and the Town Council have endorsed this.

Cheltenham.—The result of the tenders for exciter and engine is given elsewhere. The Town Council have decided that the selection of a tender for the 170-h p. engine be made later on; that the matter of the claim against the estate of the late Mr. Chapman be referred to the town clerk to deal with; and that consideration of that part of the report dealing with the extension to Suffolk-square and the increase of pressure to 200 volts be adjourned to the next meeting.

Wakefield.—The Electric Lighting Committee of the Corporation have recommended the City Council to offer to supply the light to the new county offices at a charge of 6d. per unit, with a rebate of 2d. per unit for all consumption beyond an average of two hours' use per day of the standard consumption as determined by the rebate indicator, with an undertaking that the annual payments shall not exceed £400 for the first two years, and with power to the County Council to determine the arrangement at any time upon six months' notice.

Southampton.—The Electric Lighting Committee recommend the Corporation to apply to the Local Government Board for sanction to borrow £5,300 with which to purchase land at the electric lighting station, and also sanction to borrow £50,000 in connection with the whole undertaking. Reporting on the recent fire in St. Mary-street, the Works and Fire Brigade (Joint) Committee find that the fire brigade discharged their duties efficiently, but that telephonic communication was out of order and the water partially turned off.

Exeter.—Mr. Domville, on behalf of the Electric Light Committee, having moved in the Town Council for permission to put two experimental lamps on the slopes of Northernhay in addition to those sanctioned for the plateau, Mr. Varwell said that whilst not a shareholder in the gas company he thought gas would be preferable, because they would find that if they lighted the slopes with electricity the surroundings would be heavily shadowed. The motion was eventually agreed to.

Douglas (I.o.Man).—The Douglas Southern Electric Tramway, which is worked on the overhead trolley system, is now in working order as far as Whing line, and up to this point has been thoroughly tested by Colonel Rich and pronounced satisfactory. On Monday a labourer named Mylchreest was employed in a drain, the hole of which left only his head and shoulders above the ground. The hole was between the lines of the electric tramway, and while leaning his arm on the ground to allow the passage of a down tram another passed up and took off his arm.

Dorking.—The Urban District Council have adopted a resolution that a memorial be presented to the Board of Trade applying for a provisional order under the Electric Lighting Act, 1872, to authorise the Council to supply electricity for any public or private purpose within the area of the urban district of Dorking. It was, however, stated that the sole object in proposing the motion was that if they got the permission asked for from the Board of Trade, the Council would be able to keep the matter in their own hands and prevent any private company coming in.

London Tramways.—At the North Metropolitan Tramways Company's meeting the chairman said that he hoped the question of the purchase or leasing of the line by the London County Council would be settled in October, and the terms submitted to the shareholders. At the meeting of the London Street Tramways Company, however, it was stated with regard to the questions at issue with the London County Council that the directors were still negotiating, and it was advisable that the subject should not be discussed. So the matter stands at present.

Appointments Vacant.—The Wallasey Urban District Council want an assistant electrical engineer. Practical mechanical training and experience in erection of plant and running an alternating-current station are stipulated for as essential, and the salary is £150 a year. Application is to be made to Mr. Danger, at the Board's Offices, Egremont, before the 20th inst—The National Electric Supply Company at Preston want an assistant engineer to take charge of a shift (direct current). The salary is £120.—The Dundee Commissioners want a switchboard attendant at 35s. a week. Applications to Mr. Tittensor, the city electrical engineer.

The Electrical Company, Limited.—The combined staffs of the Electrical Company, Limited and the Calmon Asbestos and Rubber Works, Charing Cross-road, W.C., have held their third annual outing. The neighbourhood chosen was Boxhill. After luncheon at the Burford Bridge Hotel, athletic competitions were improvised on the top of Boxhill itself. Advantage was taken of the occasion to prepare a surprise for the managing director, Mr. F. T. Eggers, in the shape of a testimonial of the regard in which he is held by the employés of the two companies, all of whom had subscribed to the purchase of a handsome gold chronometer watch. The presentation was made at the close of the luncheon.

Dublin.—A child has been run over by one of the electric tram-cars, but it does not appear that either the driver or the machinery were in fault. The Clontarf Commissioners have received a letter stating that the United Tramways Company Bill had passed the House of Lords. Under the Bill the Commissioners were entitled to be paid by the company a sum of £100 per annum in respect of the maintenance of the sea-wall, the company being empowered to adopt electricity as the motive power for their line. It was the intention of the company to proceed forthwith with the equipment of the line as an electric tramway. The Commissioners expressed their satisfaction at the manner in which the matter had been terminated.

Newport (Mon.).—At the meeting of the Town Council Mr. G. H Llewellyn brought up the report of the Electricity Committee, which showed that there were now 9,252 lights in use as against 8,840 in May, and that after paying working expenses, but without providing for repayment of interest and sinking fund, there was a profit for the year ended March 25 of £180. Mr Proctor Eeles was delighted to find that the light was on the road to being self-supporting, and enquired whether the total number of lights included those installed in public buildings. Mr. Llewellyn reported that the whole of the lamps in use, whether public or private, were included, but he could not give the proportion in public buildings.

Fowler-Waring Cable Company.—We are informed that the National Telephone Company have just placed a contract to the value of nearly £100,000 for dry-core telephone cables with the Fowler-Waring Cables Company, Limited. The company's factory at North Woolwich has recently been equipped with a most complete plant for the manufacture of rubber and allied substances, and for the insulation of rubber-covered wires and cables. These, together with every description of mechanical rubber goods, will now be added to the manufactures of the company. Mr. Alfred E. Mavor, who has been general manager since the formation of the company, becomes technical director. Mr. J. A. Blackwood will succeed to the secretaryship of the company in place of Mr. B. J. Diplock, who is resigning the position.

Dewsbury.—From the Corporation accounts for last year, up to March 31, it appears that the electricity supply accounts show an income of £1,893. 17s. 2d. for electricity, £37. 18s. 8d. for meter

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rents, and £12. 13s. 3d. for lamps, etc —total, £1,944. 9s. 1d. The expenditure was—generation of electricity, repairs, and main tenance, £717. 15s. 1d. ; distribution of ditto, £127. 8s. 4d ; rent and rates, £66. 18s. 8d. ; management expenses, £371. 3s. 10d. ; and insurance, £6 13s. 9d.—leaving £654. 9s. 5d. to be carried to net revenue account and balances. On net revenue the figures show that whereas there was an adverse sum of £806. 1s. 4d. as exhibited in last year's abstract, the amount has been reduced to £385. 7s. 3d. Turning to the balance-sheet, the assets are set down at £22,275. 0s. 1d., and the liabilities at £21,666. 12s , leaving a surplus of £608. 8s. 1d. Since the accounts were made up there has been a large increase in electric lighting, and the figures for next year will therefore probably be more favourable.

Waterloo and City Railway.—It is stated that the contractors expect to come out into daylight with their shield near Waterloo Station almost immediately. The work at Waterloo Station, which is of considerable magnitude and difficulty, was let to Messrs. Perry and Co. in January last. The work passes under the general offices of the company and below several of the piers supporting the arches on which Waterloo Station is built. Both offices and piers have to be underpinned to a considerable depth, and other operations requiring great care have to be carried out. The work has made very good progress, and as the water in the foundations is considerably less than when the works were commenced, it is believed that a like rate of progress will be maintained in the future. The station at the Mansion House will be constructed in two storeys, the first 12ft. underground for foot passengers, and from it arrangements will be made for descending 40ft. or 50ft. to the railway. The trains to Waterloo will start from the eastern end of Queen Victoria-street, and the station will communicate with the general foot-passengers' subway.

Brockie-Pell Arc Lamp, Limited.—This Company was registered on July 22 by Ashurst, Morris, Crisp, and Co , 17, Throgmorton-avenue, E.C., with a capital of £80,000 in £1 shares. The object is to adopt and carry into effect an agreement expressed to be made between William Shrimpton, The Associated Underwriters, Limited, and James Brockie and B. Pell, and the Company, and to carry on business as manufacturers of and dealers in electric arc lamps, incandescent lamps, etc., to carry on the general business of an electric lighting company in all its branches ; also as metal founders and workers, smiths, carpenters, builders, and merchants. The signatories are : J. A. Fuller, 50, Chatterton-road, Finsbury Park ; A. T. Bucknall, 17, Alexandra-road, N.W. ; A. D. Z. Lawson, 338, Romford-road, Forest Gate; E. Wyatt, 11, Highbury-crescent, W. ; W. H. May, 38, Cornwall-road, Brixton ; A. Eldridge, 36, Spencer-street, Hatton-road, Canonbury ; E. T. Church, 41, Coplestone-road, Denmark-park ; and the first directors—of whom there shall be not less than three nor more than seven—are to be elected by the signatories, with a qualifica- of £200, and remuneration for the chairman £350, vice-chairman £300, and ordinary directors £250 each per annum.

Callender's Cable Company.—Under the title of Callender's Cable and Construction Company, Limited, a company has been registered, with a capital of £100,000 in £5 shares, in order to adopt and carry into effect an agreement made between Callender's Bitumen, Telegraph, and Waterproof Company, Limited (the old company), and the liquidators thereof, for the acquisition by purchase or otherwise, as a going concern, of the business of electrical engineers, electricians, general engineers and contractors, manufacturers of and dealers in railway, tramway, electric, and other apparatus, etc , to develop and extend the said business in all or any of its branches. The signatories are G. Carr, 10, Belmont-road, Ilford ; G. M. Callender, Ormistone, Erith, Kent ; W. D. Reid, 25, Criffel-avenue, Streatham-hill ; S. C. Lambert, Kyrle road, Clapham Common ; C. W. Clarke, 94, Eversleigh-road, Lavender hill ; T. Petersen, 119, Worple-road, Wimbledon ; E. Thompson, 77, St. James's-road, Upper Tooting ; and the first directors, of whom there shall be not less than three nor more than seven, are H. Drake, W. O. Callender, D. P. McEwen, G. A. Elliott, W. M. Mackenzie, and T. O. Callender, with a qualification of £500 and remuneration of £900 per annum and 2½ per cent. of the net profits, divisible The registered offices of the Company is 90, Cannon street, E.C.

Manchester.—Mr. Alderman Higginbottom has called attention to a report by the Town Hall Committee that they had arranged with the National Telephone Company for the wiring and fixing of new telephone instruments in the town hall, and said he hoped those new instruments would be removed and the old ones brought back. A more abominable system than the existing telephonic system of Manchester could not be conceived by any business man. Business men felt now that they had better spend 6d. on a telegram at once than have anything to do with the telephone, which under the disgusting system now in operation simply led to a waste of time. Yet this was the system that the chairman of the company said Manchester ought to be proud of. Mr. Wilson pointed out that the new telephonic system had not got into working order yet. To make such charges as Mr. Alderman Higginbottom had done was decidedly premature. Mr. Alderman Milling said he was assured on the best authority that when every subscriber had been connected with the new arrangement the system would really be found to be perfection. Two-thirds of the underground cables were now laid, and 1,150 subscribers were already in connection with the new cables Mr. N. Bradley said the city would never get either cheapness or efficiency so long as there was a monopoly of the telephones, and the subject was then passed over.

Mitchelstown (Ireland) —At a meeting of the Board of Guardians, Mr. Fitzgerald said that at last Board meeting they had under consideration the question of the area of taxation for a scheme of public electric lighting which the Guardians proposed to adopt for Michelstown. At last meeting the Board referred his (Mr. Fitzgerald's) proposal of an area of taxation to the local committee of townspeople who had charge of the scheme for the town ratepayers. He had communicated the views of the Guardians to a meeting of the Town Committee, and the result of their deliberations was that they had adopted a scheme of electric lighting offered by Mr. Webber, the landlord of the Kingston estate. By this arrangement Mr. Webber agreed to light the streets of the town by electricity for £75 per year. Mr. Webber proposed to have 42 electric lamps, and to supply the light from sunset to midnight, and would enter into an agreement with the Guardians as local executive authority under the Electric Lighting Act, 1882, to supply the light and manage and work the scheme for a period of 22 years It was proposed to borrow from the Board of Works a sum of £450 for the purpose of erecting lamps, plant, etc., which would be all handed over to Mr. Webber. It was estimated that by adopting the proposed area, the annual assessment for the light would be about 6d. in the pound on the valuation. Mr. Fitzgerald's report was adopted.

Altrincham —The Urban District Council have received the following letter from Messrs. Andrews and Butterworth, Manchester : " We write you on behalf of a syndicate who are desirous of obtaining powers of laying down a system of tramways along the main road from Stretford to Peel Causeway, and working the same by means of electricity. We understand that concessions have already been granted by your authority for electric light for the district, and we may say that the scheme for electric tramways would be worked in conjunction with the system for electric lighting, either by the same company or an arrangement for supplying power. If you are prepared to afford facilities for the laying and working of the tramways it would enable the price of electric light to be reduced from 8d. per B.T. unit, the maximum price allowed, to 4d., and probably 3d. per unit. The syndicate would be prepared to give the local authority power to acquire their interest and property after a certain period. If the proposal is carried into effect we think the lighting of the main road would be carried out by the syndicate at a nominal cost to the local authorities, thereby affording a large saving to the Council. We should be glad of an opportunity to attend and more fully explain the scheme to the members of your Council." The clerk was instructed to ask Messrs. Andrews and Butterworth to attend a special meeting of the Council, as suggested.

Shooter's Hill (London).—The electric lighting, telephones, and fire-alarms at the Brook Hill Hospital of the Metropolitan Asylums Board have been arranged by Prof. Kennedy. The hospital is lighted throughout by electricity. The plant for this consists of three steam-engines and dynamos, of 50 i.h.p. each, and a storage battery of 64 cells, with a capacity of 500 ampere-hours. The current goes to a switchboard, and from there is distributed to two systems of mains, so arranged that the fever blocks and isolation wards are supplied from both systems, about half the lights being connected to each system. The remainder of the buildings are supplied from one system only. Each system of mains consitutes a complete ring. The lighting of the wards and offices is by incandescent lamps, arc lamps being used in the stores, kitchen, laundry, and boiler-house, and for lighting part of the grounds. The whole of the buildings are connected up by telephone to a small exchange placed in the superintendent nurse's office, in the centre of the hospital. Special arrangements have been made for telephoning to the ambulance station adjoining, and direct to the head office in London. A large gong placed near the centre of the buildings is connected to each of the separate blocks, from which it can be sounded in case of fire At the same time smaller gongs sound in some of the offices and the men's quarters. At the main gong an indicator is dropped, showing from which block the alarm has come.

Bradford.—The demand for electric light in Bradford is still increasing, but comparatively little is done in the way of using electricity for motive power. In the hope of stimulating the use of their electricity for motors, the Corporation committee have determined to reduce the charge for its supply for that purpose from 3½d. to 2½d. per unit. At a meeting of the Town Council, Mr. W. C. Dixon (chairman of the Gas and Electricity Supply Committee) moved the adoption of the minutes of that committee. Mr. C. E. Dowson pointed out that before long the Tramways Committee would have to consider the desirability of laying tramlines to Great Horton. He asked whether, in the event of the present tramway companies not offering to lease those lines, the present electricity works would if required be able, without any additional expense being incurred for extra plant, to supply electricity to work the cars on those lines He also asked at what price the current could be supplied if electricity were the motive power adopted. Mr. Dixon suggested that the question was perhaps a little premature, since the matter was one which would have to be thrashed out by the committees concerned. He had, however, no hesitation in saying that the electricity works would be able, if required, at the end of the present year to supply sufficient current to work tramways up both Bolton-road and Morley-street. The Gas and Electricity Supply Committee were enlarging their works, and were merely waiting for an opportunity to properly distribute electricity all over the borough. The minutes were adopted.

The Ediswan Catalogue.—We have received from the Edison and Swan United Electric Light Company, Limited, their new catalogue of lamps, which has just been issued to the public. The size of the catalogue (120 pages) is a sign of the growth of the incandescent lamp industry which for so many years was bound up in the above firm. It is worthy of note that the Ediswan lamp is holding its position in the market rather by the high

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standard of manufacture than by a cutting of prices. The information given in the catalogue now before us on the point of a higher efficiency in watts per candle is not very definite. The lamp bulbs are now marked with distinctive letters, A, B, C, and D, signifying that the lamps so labelled require respectively 4, 3½, 3, and 2½ watts per candle. The price of the lamps is not varied with the efficiency, and readers are warned against taking information as to the life of lamps from single experiments. The high-voltage lamps, of which so much has been written during the past winter, are strongly in evidence. They are manufactured at present by using two filaments in series in a common bulb, and hence are directly comparable with the normal voltage lamps. The efficiency at present claimed varies from 3½ to 4 watts per candle, and the prices are reasonable. The other classes of lamps illustrated are too numerous to do more than name Thus they include lamps for series work, Sunbeam lamps, focussing lamps, and the final large class of special lamps. These latter have been designed from time to time to meet the requirements of medical men, both for surgical purposes and microscopic research. This class also includes a large number of special shaped and coloured lamps for decorative effects, including that tribute to the ancient taste of the aristocracy, the candle lamp. As a work of reference this catalogue will be of use to every electrical engineer.

Lambeth (London).—The report of the special committee appointed to consider the details of the agreement for the transfer of the Vestry's provisional order for electric lighting to Mr. Sax has been submitted to the Vestry. The committee had a long interview with Mr. Sax and his legal and engineering advisers, and the only important question appeared to be the rate at which the dust should be supplied by the Vestry to Mr. Sax. Mr. Sax objected to the rate of 9d. per ton suggested by the committee, and submitted that no sum under 1s. 3d. per ton would be satisfactory or remunerative, and intimated that the cost to other vestries was not less than 1s. 8d. per ton. After discussion, the committee increased their suggested payment to 11½d. per ton, and Mr. Sax agreed to accept that figure. Mr. Sax's solicitor had intimated that there would be no difficulty in arranging all the other terms in accordance with the report of June 24. On the report coming up for confirmation, Mr. Hubbard remarked that nothing was said as to where the dust destructor would be, and the committee seemed to ignore the question of cartage. He moved that the discussion should be adjourned until the next meeting of the Vestry, and that in the meantime a copy of the draft agreement should be supplied to the vestrymen. The Clerk said the point alluded to by Mr. Hubbard was provided for in the agreement, the site for the dust destructor being subject to the approval of the Vestry. Mr. Hooper declared that Mr. Hubbard's aim had been from first to last to wreck the scheme. Mr. Orfeur pointed out that the only points that had to be decided were purely of a legal nature, and Mr. Hubbard's motion was rejected, as were two amendments by Mr. King and Mr. Prichard, and eventually the report was adopted. The vestry clerk was then authorised to insert the necessary advertisements dealing with the transfer in the *London Gazette* and in four of the local papers.

Brighton.—The borough surveyor has reported on the application from the Telegraph Department of the Post Office requesting permission to lay in telephone wires, that it was proposed to lay the wires in pipes under the roadway from the railway station down Trafalgar-street, York-place, Brunswick-place, and the Ditchling road as far as Hollingdean-road, and from thence to the boundary of the borough by means of wires affixed to poles, such poles being erected upon the highway. He saw no objection to that portion of the work proposed to be laid in pipes under the roadway, but suggested that the route be altered by taking Station-street and Cheapside instead of Trafalgar-street, but could not recommend that permission be given for the erection of any poles within the borough as shown on the upper part of Ditchling-road. It was resolved that the postal authorities be informed that the Council will sanction the laying of the proposed underground telephone wires on the route shown on the plan submitted by the surveyor, but cannot consent for the erection of poles to carry overhead telephone wires on the Ditchling-road from Hollingdean-road to the boundary of the borough as proposed. At a meeting of the Lighting Committee it was resolved that new electric light mains be laid as under—viz : in Ann-street, from London-road to the corner of St. Peter's street, at an estimated cost of £38 ; in Grand-parade and Sussex-street, from the existing main in Grand-parade opposite North-road as far as 120, Sussex-street, at an estimated cost of £132 ; in Stanford-avenue, from the termination of the existing main to 67, at an estimated cost of £50, and that the public lamps along the line of such new mains be lighted by electricity instead of gas. At a further meeting of the committee it was resolved that an electricity main be laid in Southover-street at an estimated cost of £290, and that the existing gas lamps in that street be lighted by electricity instead of gas. These resolutions have now been confirmed by the Town Council.

Bangor (North Wales).—The following was a minute of the meeting of the Electric Lighting Committee : "It was mentioned that Mr. Medhurst had submitted an account for £100 for his services in connection with the electric lighting scheme. It was resolved that the Council be recommended to pay same. The notices received from the Bangor Electric Supply Company and the Manchester Edison-Swan Company were considered, and it was resolved that, inasmuch as the Council have decided to apply for a provisional order for the supply of electricity within the borough, they (the Council) are unable to comply with the request of the companies." Upon this coming up for confirmation in the Town Council, Mr. W. Bayne asked if a resolution had not been passed by the Council to the effect that a sum of £50 should be paid to Mr. Medhurst in full discharge of all claims in case the electric light was not proceeded with. Mr. T. Lewis said that a resolution was proposed by Dr. Grey Edwards, seconded by Mr. R Davies, and carried *nem. con.*, on September 20, 1895, providing that, if the Council obtained the necessary powers to proceed with the electric lighting scheme, Mr. Medhurst be appointed engineer at a remuneration of £650, this sum to include charges for plans specifications, and superintendence of works. If, however, the Council, owing to unforeseen circumstances, did not proceed to obtain the necessary powers that Mr. Medhurst be paid the sum of £50 in full discharge of all claims. Mr. W. Bayne failed to see how they could adopt the committee's recommendation in the face of the resolution referred to. He moved that the matter be referred back to the committee. Mr. Foster, the mover of the committee's report, said the extra £50 was accounted for by Mr. Medhurst having to prepare five or six plans instead of one. Mr. R. Davies said that Mr. Medhurst had been instructed to prepare additional plans subsequent to the meeting of the Council to which Mr. Lewis had alluded. Ultimately Mr. Bayne's amendment was agreed to, the remainder of the committee's minutes being confirmed.

Dundee.—At a meeting of the Gas Committee of the Town Council the question of the cost of electric lighting lamps in High street has been under consideration, and a remit was made to the interim electrical engineer to report on the cost, and state whether the electric lamps should be dispensed with or improved. He was also instructed to report with reference to the electric lighting of public lamps in other towns. A report was submitted by the interim engineer on the lighting area. He said the present lighting system was installed over three years ago, when plant for supplying 10,000 lamps was put down. At present there were about 17,000 lamps connected with their mains. No additional mains had been laid in the Wellgate district since the commencement, and there were several complaints from consumers last winter regarding the pressure. During the present year additional lamps had been connected, so that heavier mains were most urgently required to cope with the demand. Under existing circumstances it would not be possible to keep within the limit prescribed by the Board of Trade. He would recommend that the Overgate and Whitehall-street mains, which were overloaded, be also attended to. Enquiries had been made for supply in Dock-street and South Tay-street, in neither of which streets were there mains laid, though they were within the area of supply. He would urge that all further supplies be given at a pressure of 200 volts. This would be a great benefit to them, and would result in a saving of from 20 to 30 per cent. of copper on any further extension. By adopting 200 volts as the standard pressure for future supplies, the work of changing over to the three-wire system would be greatly simplified. The proposed increase of mains would mean a total cost of £1,047, as follows: Wellgate and district, £525 ; Whitehall-street, £32 ; Overgate, £210 ; Dock-street (200-volt supply), £110 ; and South Tay street, £170. The report was approved generally, and the clerk was instructed to advertise for cables for the Wellgate district, Overgate, and Whitehall-street. The committee have agreed to recommend that Mr. W. A. Tittensor, interim electrical engineer, should be appointed electrical engineer at a salary of £200 per annum. The committee were of opinion that no assistant electrical engineer would be necessary, but that a remit should be made to the convener and the electrical engineer to adjust and increase the subordinate staff so far as necessary.

Bury St. Edmunds.—It will be remembered that at their former meeting the Town Council adopted a scheme for lighting the whole of the streets of the town with incandescent lamps and supplying private lighting within a restricted area, the system adopted being a continuous-current one on the three-wire system with supply at 220 volts. There was considerable opposition, but an effective debate of the matter on its merits was hampered by the fact of a large number of the town councillors being interested in the local gas company. The Electric Lighting Committee were unanimous in favour of the scheme, and a poll or some other means of ascertaining the feeling of the ratepayers was refused. The subject came up again on Tuesday, when Alderman Lake remarked that at the former meeting Alderman Gough suggested that he was prepared to give a guarantee that the electric lighting of the borough should not be any expense to the ratepayers whatever. He expressed his willingness to take the matter over, holding himself liable for any possible loss, and receiving whatever profit might accrue from the adoption of the scheme The idea had, however, been ridiculed ; but he (Alderman Lake) would ask whether it was not quite possible to form a small company to take up the matter ? If the ratepayers were so foolish as to allow them to take the profits, he had no objection. He was quite prepared to be one of a small company willing to take over the electric lighting of the town, guaranteeing the ratepayers against loss for 20 years, and taking the profits during that time. He should like to know whether members of the Town Council could legally become members of such a company. If they could, then there would be no doubt as to the necessary guarantee being forthcoming, and the members of the Ratepayers' Association would be relieved from the need for parading in front of the Mayor's premises on the following Thursday evening. Of course, others besides members of the Town Council would constitute the company. Mr. Turner did not think the Town Council could recognise a company formed of its own members. He had received an intimation that one or more contractors were willing to undertake the same thing as Alderman Lake had proposed. Mr. Hooper did not think members of the Town Council were debarred from becoming

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associated with an electric lighting company any more than members of the Town Council being connected with the gas company. The Town Clerk (Mr. C. E. Salmon) felt that the point involved was one of grave importance, and wished for time to carefully consider it. He would consult his parliamentary agent.

Plymouth.—Mr. Rider's report we give in full elsewhere. On its consideration by the Town Council, Mr. Willoughby moved the adoption of the committee's recommendation that application should be made to the Local Government Board to borrow the sum of £45,000 to carry out the work. Application has already been made for sanction to borrow £1,000 for the same purpose. Mr. Elliott questioned whether they would be justified in spending two and a half times as much in lighting the town with electricity as they were now spending on gas. Whilst he entirely agreed with the principle, he thought they as a Council should have some idea as to the total cost before sanctioning a portion of it. Mr. J. Yeo said that whilst for business purposes the electric light would be a good thing, he questioned the wisdom of incurring a cost of £1,184 for public lighting when that was done at the present time for £475. Mr. J. Willoughby said the experience of other towns was that the more electric light was used the greater was the consumption of gas. There could not be a doubt that the lighting of Plymouth by electricity would make it one of the most attractive places in England; and it should not be forgotten that the more the light was used the cheaper it would become. It was calculated that there would be a saving ultimately of £4,000 per annum by the substitution of electric for horse power for the trams. Mr. Page reminded the Council that it was shown that the loss on the public lighting would be nearly £700 per annum, and moved that the further consideration of the minute be deferred until after November 9 next. There was no seconder to this. Mr. J. Willoughby said the buildings it was proposed to erect would be sufficient to permit of the scheme being extended all over the town, but the plant proposed would not. It would be possible to supply the hotels and public buildings with the light up to a maximum of 12 000 lights. The Mayor said he had just had a consultation with the town clerk, and found that their electric lighting powers would soon expire. It was therefore necessary that some definite action should be taken without further delay. It would be an extraordinary thing if they, as a Council, were to pass a vote of want of confidence in themselves. Mr. J. Willoughby said he never expected to see every part of Plymouth lighted with electricity. There was not a town in England where that was done. Mr. Page seemed utterly unable to see that what he imagined was a loss on the public lighting was really no loss at all when they considered that in 30 years the property would be their own. The recommendation of the committee was approved.

Glasgow.—The Corporation have discussed a proposal by the Tramways Committee to equip the route from Mitchell-street to Springburn with electric cars propelled on the overhead system. When the minutes were put before the meeting, Mr. Paton, the convener, explained that the proposal had only been carried in committee by his casting vote. He had subsequently reconsidered the matter, and had come to the conclusion to move that the matter be sent back to the committee for further consideration. Mr. Angus Campbell opposed this, and the Lord Provost said that not one member of the committee who saw the working of the electric tramways on the Continent had gone back from his views, but the committee did not now say that they considered the Springburn route the proper route on which to try the system, or that the present was the proper time. Personally, he thought the Springburn route was the proper one on which to try the experiment, but he did not think it was the proper time. There was no hurry, and he thought they should not refuse the request of the convener, but allow him to take the matter back. Mr. W. F. Anderson moved that further consideration of the proposal should be delayed for six months, and Bailie John Murray seconded this. Mr. J. H. Martin moved the amendment which he made in committee—namely, that further consideration of the matter be delayed. Bailie Jack seconded, and Mr. Primrose supported delay. They were, he thought, on the eve of great developments in electric haulage. Perhaps within six months the conduit system might be demonstrated to be the best. Bailie Burt said that the present cars were at certain times of the day very much overcrowded, and that of all the mechanical methods of traction the one which presented fewest objections was the overhead system. Mr. Paton said that when the Corporation took over the tramways it was on the express understanding that they were to introduce mechanical motors as soon as possible. Horses were being superseded by other motors, and the overhead wire system was the one most generally adopted. Cable haulage was making no progress. All over the Continent and America it was electric tramways or nothing. The public in this country, unfortunately, did not know much about electric traction, and a number of bogeys had been held before them. Possibly the committee had made a mistake in going too rapidly at the thing when rather they should have been educating the public. In the circumstances, he thought they would be doing wise in sending the matter back again to the committee. Mr. Campbell subsequently withdrew his motion, and on a vote being taken, as against the other motions, Mr. Paton's motion to have the subject sent back was carried by a large majority. The Sub-Committee on Halls recommended that St. Andrew's Halls should be lighted by electricity, and Bailie Alexander, in moving the adoption of the minutes, explained that the cost was estimated at £1,647. He asked that the committee should have full powers to take the lowest offer for the work. This recommendation was adopted. The sub-committee on electric lighting have reported, with reference to the resolution to experiment with eight of the arc lamps at the west end of Sauchiehall-street, that they had approved of a design by Messrs. Macfarlane and Co. of an arm and pendant projecting 3ft. only from the pillar, which will admit of the lamp being made a fixture, and the Town Council have passed the report. The central railway was recently opened for passenger traffic. The carriages are at present lighted with gas, but in the course of a few days an experiment is to be made with electric lighting.

Blackburn.—The Town Council have decided that application should be made to the Local Government Board, in pursuance of the provisions of the Electric Lighting Acts and of the Blackburn Electric Lighting Order, 1890, for their sanction to the borrowing by the Corporation of the further sum of £15,000 for electric lighting purposes. At the half-yearly meeting of the Blackburn Corporation Tramways Company. Limited, Mr. R. A. Jackson (the chairman), in introducing the question of electric traction, remarked that some of the directors had inspected the gas traction in use on the Lytham to Blackpool tramway, and had come to the conclusion that such a motive power would not do for Blackburn. Mr. Jackson gave details of the cost of the present motive power of the company, stating that last year the cost on the Preston-road section, including all expenses, was 9·84d. per mile, Witton 9·21d., and the steam section 7·08d. The provision of motive power alone on the steam section was 2·29d. per mile run, Preston-road section 6·16d., or an average for the two of 4·29d. per mile. He and another director had visited Bristol and inspected the electric tramway there, which had run without a hitch since it had been got into proper working order. The directors had had interviews with the Blackburn Corporation with regard to the use of electricity as a motive power for their cars, but at present they had no offer from the Corporation. As the matter stood at present, the Corporation did not want to go into it again unless the directors of the company were prepared to enter into a fixed agreement. The Corporation had offered to supply them with electricity at 3d. per mile run, up to 130,000 miles; but if the distance were increased to 180,000 miles, then they were prepared to decrease the price to 2½d. per running mile. The Corporation undertook to bond the rails, to put the necessary plant down in the depôts, and to erect the standards in the streets; in fact, the Corporation would do everything except find the cars. The company would therefore have to provide their own cars and to make any alterations that were required in the passing places and in their own depôts. The difference between the cost of their present motive power and the cost of electric traction he estimated at £650 a year in favour of the latter. The cost of the cars it was estimated would be about £700 each. Replying to a shareholder, who asked if the directors were unanimously in favour of electricity, the Chairman said that the opinion of the directors was that the matter should be allowed to stand over for a year or two. Mr. Beesley (a director) thought that the proper time to utilise electric traction was when their present engines had been worn out. Mr. Magerison (another director) was of opinion that the question of at once adopting electricity as a motive power deserved serious consideration, but they ought to pay off the remaining £8,000 debenture-holders before they talked about borrowing money for the purposes of electric traction. Eventually it was decided to defer the matter for 12 months, but the directors were empowered to call a special meeting of shareholders at any time they considered necessary.

Fort William (Inverness).—The price of gas supplied to Fort William is said to be probably the highest in Scotland, and the quality has been complained of. Consequently, four or five years ago, the question of lighting the place with electricity received consideration, but the proposals then made obtained no great support, and the attempt was abandoned. About a year ago the proposal was renewed. At first there seemed no good prospect of raising the necessary capital as the sum required was rather large for local appropriation, but was small for ready acceptance in the open money market. About the beginning of the present year a limited liability company was formed under the name of the Fort William Electric Lighting Company, Limited, The necessary capital—£7,000—was subscribed, and by the beginning of March a commencement with the preliminary works was made. The company offers to supply electric light at its dearest at a cheaper rate than has been paid for gas, and for power during the day at half-price The progress of the works has already been noted in these columns, but the following gives some additional information. The source of power which first suggested itself was the River Nevis, which falls into Loch Linnhe close to the town, and on which, at a distance of less than a mile, there is a suitable fall. This was the place originally proposed as the position of the turbines, but when the owner of the salmon fishing on the river was approached on the subject his conditions were found impossible. Another source of power had therefore to be looked for. This was found in the River Kiachnish, which falls into Loch Linnhe, about three miles below Fort William. The stream itself is considerably smaller than the Nevis, but the construction of a lade of about 1,200 yards allows a fall of 120ft., and brings the application of the power by so much nearer the town. At this point a building has been erected in which are placed the turbines and dynamos required for producing the electricity, which is conveyed thence by an overhead line to the central station at Fort William, from which it is distributed by cables, partly overhead and partly underground. The poles for the overhead cables are placed at a distance of 60 yards from each other. The cables are of 19 strand 13 gauge copper wire. The total length of cable is about 14 miles. The power is applied by means of

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two 60-h.p. vortex turbines supplied by Gilkes and Co., Kendal, which drive two continuous-current dynamos by Laurence, Scott, and Co., Norwich. The station at Fort William contains an accumulator of 164 cells, E.P.S. central-station type, with the requisite switchboard for distributing the current. The lamps used are 16 c.p., voltage 150. The cost to the consumer is to be 9d. per Board of Trade unit from an hour before sunset till nine o'clock in the evening, and for the rest of the 24 hours 4½d. per unit. The town is, in the meantime, to have four arc lights of 1,000 c.p. each, and over 60 incandescent lights, each of 16 c.p The total cost for lighting the streets is for the present £180 per annum. Terms have also been arranged on which the street-lighting may be extended. Arrangements have already been made for the electric lighting of the principal shops and hotels, the churches, and other public buildings, and a number of private houses. The first trial of the new light was made on Monday night in the Station Hotel, and was in all respects successful. It will be some time yet, however, before the streets can be lighted and the light generally supplied. The chief engineer of the work was Mr. R. T. Yorke, with Mr. H. W. Bagot and Mr. A. Cottrill Dormer assistants. The lade was laid out by Mr. John Paterson, Fort William, and the contractor for it and for the turbine-house was Mr. A. Bremner, Fortingall. The contractors for the accumulator-house at Fort William were Messrs. J. and P. Maclachlan, Larbert.

PROVISIONAL PATENTS, 1896.

AUGUST 4.

17161. **The manufacture of an improved active material for the plates or electrodes of electric accumulators.** Siegfried Hammacher, 11, Southampton - buildings, Chancery-lane, London.

17180. **Improvements in combined typewriters and electro-telegraphic transmitters.** William Lloyd Wise, 46, Lincoln's-inn-fields London. (World Flash Company, United States.) (Complete specification.)

17187. **An improved electric cable or conductor for electric fire or other alarm systems.** Charles Darwin Tisdale and John Duncklee Gould, 45, Southampton buildings, Chancery-lane, London. (Complete specification.)

17200. **Improvements in and in connection with supports for electric lamps.** William Lloyd Wise, 46, Lincoln's-inn-fields, London. (Frank E. Kinsman, United States)

17203. **Improvements in methods and means for electric regulation of power.** Horace Bigelow Gale and Charles Trotter Thompson, 24, Southampton-buildings, Chancery-lane, London. (Complete specification.)

17222. **Improvements in portable telephones.** Charles de Ricaris, 45, Southampton-buildings, Chancery-lane, London.

AUGUST 5.

17257. **Improvements in electric meters.** Emile Batault, 21, Ely-place, Holborn-circus, London.

17338. **Improved device for automatically throwing into circuit reserve electric lamps, motors, or resistances in case of breakdown, and for protective purposes.** Edmund Jokl Wilhelm Maximilian Christian and George Kemp 46, Lincoln's-inn-fields, London.

AUGUST 6

17346. **Improvements in or connected with secondary or storage batteries.** Ferdinand Francis Ernest Heyse and William Hopkin Akester, 57, Chancery-lane, London.

17363. **Improvements in electromotors.** Rankin Kennedy, 33, Gladstone-street, Leeds-road, Bradford.

17389. **Improvements in electric rock drills, caulking tools, and other reciprocating machines.** Albion Thomas Snell 52, Chancery-lane, London.

17395. **Improvements in magnetic cut-outs.** Leonard Andrews, 166, Fleet-street, London.

AUGUST 7.

17436. **Improvements in compasses.** Thomas Bassnett, 4, Clayton-square, Liverpool.

AUGUST 8.

17557. **Improvements in continuous-current dynamo-electric generators and motors.** Sebastian Ziani de Ferranti, 27, Charterhouse-square, London.

17558. **Improvements in dynamo-electric generators and motors.** Sebastian Ziani de Ferranti, 27, Charterhouse-square, London.

17563. **Improvements relating to electric traction.** Thomas Meacock, 18, Southampton-buildings, Chancery-lane, London.

17577. **Improvements in electrical measuring instruments.** George Keith Buller Elphinstone, 101, St. Martin's-lane, London.

17578. **Improvements in electrical signalling apparatus.** George Keith Buller Elphinstone, 101, St Martin's-lane, London.

17579. **Improvements in electric railway systems.** Daniel MacLaughlin Therrell, 23, Southampton - buildings, Chancery - lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, January 9, 1896, being date of application in United States.)

17608. **Improvements in means or apparatus for effecting the electro-deposition of zinc or other metals upon tubes or other circular or analogous objects.** The Cowper-Coles Galvanising Syndicate, Limited, and Sherard Osborn Cowper-Coles, 47, Lincoln's-inn-fields, London.

SPECIFICATIONS PUBLISHED.

1895.

11752.* **Electro-deposition of gold and silver.** Andreoli. (Amended specification.)

14438. **Electrical annunciators and pushes or calling devices connected therewith.** Stamm.

15889. **Construction and working of electric arc lamps.** La Société les Fils d'Adolphe Mougin. (Date applied for under International Convention, February 11, 1895)

16450. **Stage or like arc lamps for alternating currents.** Sykes.

17058. **Periodically ringing bells and sounding whistles, syrens, or the like, and registering the same, and electrical apparatus therefor.** Berry.

17400. **Permanent way, electric conduits, and conductors of electric tramways.** Wood and Brodie.

17481. **Electroliers.** Best.

21638. **Electrical switches.** Fielding.

1896.

8163. **Alarm clock and apparatus for automatically operating electric signals at definite hours.** Mesmer-Weber.

9480. **Collector for conduit and similar electric railways and the like** Crotz Allen. and Kelly.

11419. **Devices for electrically lighting the wicks of oil lamps.** Fitzpatrick. (The Empire Self-Lighting Oil Lamp Company.)

13074. **Manufacture of electrical resistances.** Marquand and Lowdon.

13079. **Dry batteries and the like.** Thompson. (Lesenberg.)

13295. **Electrically-controlled railway signals.** Thompson. (McBrien, Wayland, and Fleming.)

13521. **Manufacture of carbon anodes for electrolytical processes.** Jensen. (Cappelen and Cappelen.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5¾-6¼
Brush Company, Ordinary	3	1-1¼
—— Non. Cum., 6 per cent. Pref.	2	1¼-1½
—— 4½ per cent. Debenture Stock	100	112-115
Charing Cross and Strand	5	8¾ 9¼
Chelsea Electricity Company	5	7¾-8¼
—— 4½ per cent. Debentures	100	114-116
City of London, Ordinary	10	15½-16½
—— 6 per cent. Cumulative Pref.	10	17-18
—— 5 per cent. Debenture Stock	100	133-137
City and South London Railway, Consolidated Ordinary	100	46 48
—— 4 per cent. Debenture Stock	100	136-128
—— 5 per cent. Pref. Shares	10	14½-15
County of London and Brush Provincial Co., Ordinary	10	8-9
—— 6 per cent. Cum. Pref.	10	13½ 14
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
Edison and Swan United Ordinary	3	1¾-2¼
—— 4½ per cent. Debentures	100	103-106
Electric Construction, Limited	2	1⅝-1⅞
—— 7 per cent. Cumulative Pref.	2	2¾-3¼
Elmore's Copper Depositing	2	[illegible]
Elmore's Wire Company	2	[illegible]
W. T. Henley's Telegraph Works, Ordinary	10	17½-18½
—— 7 per cent. Preference	10	18-19
—— 4½ per cent. Debentures	100	109-114
House-to-House Company, Ordinary	5	4 4½
—— 7 per cent. Preference	5	8-8½
India Rubber and Gutta Percha Works	10	22-23
—— 4½ per cent. Debentures	100	106-109
Isle of Man Electric Trams, Ordinary	1	1⅜-1⅞
—— 6 per cent. Preference	1	1⅜-1½
Kensington and Knightsbridge Ordinary	5	9½-10
—— 6 per cent. Pref.	5	7¾ 8¼
Liverpool Electric Supply, Ordinary	5	8-8¼
Liverpool Overhead Railway	10	13¾-13⅞
—— 5 per cent. Pref.	10	17⅛-17⅝
—— 4 per cent. Mortgage Debentures of £100	100	112½-114½
London Electric Supply	5	⅞-1⅛
Metropolitan Electric Supply	10	13¼-13¾
—— 4½ per cent. First Mortgage Debenture Stock	100	119-123
National Telephone, Ordinary	5	7¾ 8
—— 6 per cent. Cum. First Pref.	10	17-19
—— 6 per cent. Cum. Second Pref.	10	17-18
—— 5 per cent. Non. Cum. Third Pref.	5	6⅞-7⅛
—— 3½ per cent. Deb. Stock	100	107-110
Notting Hill Company	10	11-12
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8¼-8¾
—— £4½ shares	4½	7¼-7¾
Oriental Telephone and Electric Company	1	¾-⅞
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	105-107
Southampton Electric Company	5	4¾-5¼
St. James's and Pall Mall, Ordinary	5	12½-13½
—— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	39-42
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary		8-8½
Westminster Electric Supply, Ordinary	5	11-12
Yorkshire House-to-House	5	7⅝-7⅞

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NOTES.

Obituary.—The death is announced of Prof. H. A. Newton, the mathematician, of Yale University in America.

Personal.—Mr. J. Snell, of St. Pancras, is to be recommended to the Sunderland Town Council for the post of electrical engineer for the Wearside borough.

"Electron."—We have to acknowledge from Madrid the receipt of copies of *Electron*. The publication is a comparatively new one, and is devoted to the interests of the Spanish telegraphic service.

Matrimonial.—The marriage of Mr. T. M. Furniss, formerly electrical engineer at Larne, and now with Messrs. J. C. Howells and Co., of London, took place at Carlow on Tuesday last. The bride was Miss M. E. Burne, of Ballinacarrig.

The Enclosed Arc.—An application for an American patent has been filed by Mr. O. S. Lyford, of Chicago, for an arc lamp with an enclosing chamber for the carbon electrodes normally sealed from the external air, but with a porous or fibrous diaphragm for securing the equalisation of any substantial difference between the external and internal pressures.

East London Technical College.—We have to acknowledge the receipt of the calendar for next winter's session of the technical college in connection with the People's Palace at Whitechapel. Attention is called to the fact that considerable developments have been made, more especially in extending and systematising the instruction in the day classes.

The Jacques Cell.—From experiments which have been made in America by Mr. C. J. Reed before the Franklin Institute, it appears that at any rate a large portion of the current obtained from the carbon, hot soda, and iron battery of Dr. Jacques is thermoelectric in its origin. It seems that a current is still obtained if the carbon is replaced by a metal that is not oxydised and a gas containing no oxygen is used to "aerate" the hot soda.

Cairo Tramway.—We have already briefly noted the opening of the Cairo electric tramway by Fakhry Pasha, the Minister of Public Works. From the Egyptian *Journal Officiel*, which is now to hand, it appears that the line runs from Bulaq to the Citadel. There will be two classes, and the fares will four, six, or eight milliémes, according to distance, for second class, and six, eight, and ten milliémes first class. A milliéme is somewhat less than a farthing. Officers and soldiers will in general be carried at about half fares.

Publications Received.—We have to acknowledge the receipt of the August issue of the *Journal* of the Chemical Society. There are more than 230 pages by Dr. Perkin "On Magnetic Rotatory Power, especially of Aromatic Compounds." We have not at present had time to find out what it all comes to. Several of the abstracts relate to matters connected with electrolysis, and some of them may possibly be drawn on to supply subjects for these notes. From Chicago we have received the *Journal* of the Western Society of Engineers.

Too Successful.—The position of the Hull Electric Lighting Committee is not exactly a pleasant one just at present. The electric lighting is a success. The committee have already allowed about 3,000 more lamps to be attached to the station than the station was originally estimated to supply, and they are still receiving additional applications for current. Their difficulty is that the Council cannot agree as to allowing them to make extensions. Meanwhile, what is a poor committee to do except keep on reporting? Only, unfortunately, one cannot generate and supply current with reports alone—machinery and mains are also necessary.

The Metric System.—The Bill which was introduced (not to be passed) by the President of the Board of Trade at the end of the session, and which it is intended to get through Parliament next session, will legalise the use of the metric weights and measures, and contain in its schedules tabular statements of the relation of those weights and measures to those in use in this country at the present time. It appears that it was the Weights and Measures Act of 1878 which "illegalised" the previously legal but unused metric weights and measures.

The Telegraph in Ceylon.—We understand from an Indian contemporary that the telegraph and telephone service in Ceylon is not what it should be. The blame seems to lie in one of two directions. The first is the climate, and the second the organisation of the staff. The quick growth of the vegetation and the salt spray brought inland by the south-west monsoons play havoc with the insulation of the overhead wires. The climate may, at the same time, affect the operatives, but we understand that improvements in their outfit are being rapidly carried out, and that several orders for stores may shortly be placed in England.

Trolley Wire.—A way of stringing trolley wire devised by Mr. Walker is stated by the *Electric Railway Gazette* to be used on the Sioux City line. The reel containing the wire is placed on the front platform of a car, so that it may revolve and put a tension on the wire. From there the wire passes over a wheel on the roof, where the men standing on the platform can readily attach it to the supports. The wire is live and the current for propelling the car passes through it. By this means it is stated that it is possible to string the wire at the rate of about a mile a day. To our European notions it looks, to put it in the mildest way, just a little bit risky.

St. Mary's Woolnoth.—Before Parliament rose the House of Lords agreed to the Commons' amendments to the Lords' amendments to the Bill of the City and South London Railway Company. In the Commons, the chairman of the committees intimated that the railway company had consented to take the Bill as amended. The upshot of it all is that the troubles of the company, caused by the admirers of St. Mary's not knowing their own minds, have come to an end at last, and that church will remain—with a railway station underneath it. Although it is now all over, this has not prevented any amount of correspondence on the subject in the *Times*.

Neglected Talent.—The bringing out of motorcart companies seems just at present to be very much in vogue. In case the supply of inventors and motors runs out it may be well to mention there is at the present moment one in Coventry workhouse which is available to be exploited. It was, indeed, suggested that the Guardians should bring the invention out, doubtless for the benefit of the ratepayers, but the Local Government Board is known to hold old-fashioned ideas on the subject of corporate enterprise, and would hardly sanction a loan for the purpose. So we shall probably never see the rate collector going round and paying a dividend instead of collecting a rate from the inhabitants of Coventry.

The Wonders of Electricity.—Two of these are reported this week by the old and well-tried specialists who supply the Dalziel telegrams. The first is merely a new fleet of warships for the Japanese Government. These, though small, are thickly armoured, and though they have their screws in the middle instead of in the proper place,

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being driven by electricity, naturally go 40 knots an hour. Anybody can mix up the dimensions of a ship, but an apparatus devised by Superintendent Reardon, of the Perkins School for the Blind in Boston, U.S.A., is a distinct advance. This discovery, which has been "perfected," "if it does not enable any totally blind to see, increases to a wonderful degree the visual power of those to whom ordinary aids have been almost unavailing." It does this by sending the current from a small pocket battery through an arrangement of selenium, glass, and vulcanite, and the "sight centres." After this a merely riotous meeting in Rome to protest against electric tramways falls flat.

The Trunk Line Telephones.—At the meeting of the council of the Sheffield Chamber of Commerce, the secretary reported that a subscriber of the Chamber had made complaint that, notwithstanding the recent declaration by the Treasury that any user of the trunk wire, if he found that the three minutes allowed were not sufficient, was entitled to have another three minutes' consecutive to the first on payment of a double fee, he had been refused the second period. The Secretary said he had brought the circumstances under the notice of the Treasury, who had promised to make enquiry into the matter. The secretary was directed by the Chamber to call to the attention of the commercial community of the district, through the Press, that any trader using the trunk telephone wire is entitled to, and should insist on, if necessary, a second period of three minutes being allowed him on payment of a second fee, thus allowing a conversation of six minutes. But why should not the Post Office get the officials informed of the rules? It is not much good "insisting" through a telephone wire.

Not the Way.—At Bury St. Edmunds they have been discussing the economics of the incandescent electric lamp with the aid of a band and banners, a procession, irrelevant speeches, and all the ordinary paraphernalia of a political "demonstration." This is a method which, though greatly favoured for the treatment of complicated questions of statecraft and sociology, has not hitherto been considered applicable to the comparatively simple problems of engineering and accounts. In the scheme proposed for adoption at Bury St. Edmunds there are points as to which any ratepayer who happened to possess a knowledge of the subject might reasonably require further information before he approved it, but if the electric lighting is not to be the town's affair, but the committee's own private speculation, what was there to "demonstrate" about? The curious condition of things will come in the future when the Town Council tries to discuss any question of public lighting. With the aldermen and councillors on the left of the table disfranchised because they hold gas shares, and those on the right voiceless because of their connection with the electric lighting syndicate, it would be rather distressing if the miserable remnant that belonged to neither side were either to develop ideas of its own or to show its impartiality by voting for oil or candles. But, seriously, it will demand considerable courage on the part of that remnant to decide between the rival interests.

Newcastle Science College.—We have received a copy of the calendar of the Durham College of Science, Newcastle-on-Tyne, for the session 1896-7, and a prospectus of both the evening and day classes. A portion of the work done there which may be specially noticed is that of the evening classes organised to meet the wants of the rising generation of artisans. The instruction is practically free, as will be seen from the following clause: "Apprentices and workmen will be admitted to the classes in elementary mathematics, technical electricity, steam boilers, and chemistry of fuel, iron, and steel at a fee of 2s. 6d. for each course, which fee will be returned if they attend to the satisfaction of the lecturers and apply for its repayment before June 24.' Special courses of lectures will be delivered on telegraphy and telephony by D. H. Kennedy, while the general department of physics is under the control of Prof. H. Stroud, M.A. We also notice a course of lectures on the "Principles of the Law of Contract," by Mr. H. S. Mundahl, B.A., LL.B., which should be of great interest to the rising business man. Evening students can now matriculate at the college and obtain the different degrees. The prospectus of the day classes shows what a large range of subjects are taught at the college. The new course commences on September 28, on which day the matriculation examination for new students will be held. We note that several scholarships will then be open for competition.

Dissociation and Electrolysis.—An abstract of a paper on electrolytic dissociation and light absorption which was contributed by Mr. F. G. Donnan to the *Zeitschrift für Physikalischen Chemie* has been given in the *Journal* of the Chemical Society. Mr. Donnan has investigated the light absorption of solutions of violuric acid by aid of a colorimeter, of which diagrams and a description are given. The dissociation in N/32, N/64, N/128, and N/256 solutions are calculated from the absorption, and the results are found to agree well with those obtained from the conductivity. The addition of hydrogen chloride causes a decrease in the dissociation, and the concordance of the colorimetric and conductivity results is again satisfactory. Parahydroxybenzoic acid was also employed instead of hydrogen chloride owing to the approximate equality of its dissociation constant to that of violuric acid, and in this case, as also for the addition of levulinic and acetic acids, satisfactory results for the decrease in dissociation were obtained calorimetrically. The addition of sodium chloride gives rise to an indeterminable equation for the concentration of the colouring ions; but, on the assumption that the undissociated sodium violurate possesses an absorptive power equal to that of the acid ion, an approximate result is obtained which is, however, not in good agreement with the colorimetric observations. The assumption is afterwards shown to be not quite correct, as the absorptive power of the salt is slightly greater than that of the acid ion.

The Locomotives on Highways Bill.—We give in another column the text of this Act, which has now become law, and which is also the cause of a jubilant letter in our correspondence column. We learn from the latter that the president of the Self-Propelled Traffic Association is mainly responsible for the concession embodied in the Act. There is no doubt that the legislation of the country has hindered the development of self-propelled vehicles, and it is to be trusted that a practical advance in the matter will now be made. It is useless to go into raptures, as has been the custom of the non-technical Press of late, over every vehicle that runs alone. What is wanted is rather a cheaper means of transport on the ordinary roads than is afforded by horse traffic. The matter may be taken up by gentlemen who, to quote our correspondent's letter, are "entirely disinterested and unbiassed by personal or pecuniary motives," but it is the personal and pecuniary advantages to the users that are wanted to make the movement a success. Up to the present the chief development has been that of selling or trying to sell doubtful patents to the public. A really valuable patent would probably come first under the consideration of men of business, who would not care to divide profits with the public, if in any way they could avoid it. At any rate, the passing of the Act

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is to be commended, and those gentlemen who have assisted the Self-Propelled Association in obtaining the Act are to be congratulated. It is to be hoped that the power vested in the Local Government Board to frame regulations will not be used in such a manner as to vitiate any of the concessions intended to be granted to those who desire to use self-propelled vehicles on the ordinary roads.

The Dynamic Forces in Iron-clad Armatures.—We have already referred to this subject in a note on some theories or opinions of Mr. T. Wolcott, and complained that no facts were given. A more practical contribution to the knowledge of the subject has recently appeared in the *Electrical World* in the form of a record of some experiments by Messrs. Houston and Kennelly. The article is reprinted in this issue, and will repay careful reading. An examination of the results is made somewhat difficult by a lack of detail as to the dimensions of the apparatus used, but the conclusions are practical, and as far as they go are satisfactory in showing how little real knowledge of the subject at present exists. In the starting position the experimenters find that practically all the torque is exerted on the iron of the armature, and only some 1·6 per cent. on the copper conductors. This latter fact is what our theories lead us to expect, as in the stationary condition practically no induction passes through the copper wire. The question still requiring attention, in our opinion, is the very important one as to whether when running these conditions alter, or, in other words, is the static pull on the iron core of a toothed armature any greater than that on the wires of a smooth core with the same M.M.F. and air-gap. An easy way of testing this roughly would be to compare the static and running torque of a toothed armature under the same conditions as to armature current and field strength. The experiments also bring out the fact that the motion of the conductors in the slot does not generate E.M.F. But when the whole core is moved there is an E.M.F. generated corresponding to a cutting or threading of lines of force, and it may be suggested that experiments are still wanting to prove that a force is not then exerted on the copper.

Incandescent Lamp Ring.—It is stated by the *Western Electrician* of America that the various lamp manufacturers have decided on a fixed price for all lamps sold in the States. The tariff is to vary with the candle power—as follows:

Candle-power of lamp.	Price per lamp for small quantities.	Price per lamp in standard packages.
8 to 25	11d.	10d.
32	1s. 5½d.	1s. 3d.
50	2s. 3½d.	2s. 1d.
100	4s. 7d.	4s. 2d.
150	6s. 10½d.	6s. 3d.

These prices are for lamps with Edison and Westinghouse sockets. In lamps with Thomson-Houston, United States, Brush-Swan, or Schaeffer sockets, ½d. more per lamp must be charged. With Hawkeye sockets 1d. more, and for any other kind 1½d. more. The sizes of the standard packages are defined as containing numbers of lamps as follows: for 8-c.p. to 25-c.p. lamps, 200 lamps; 32-c.p. or 50-c.p. lamps, 100 lamps; 100-c.p. or 150-c.p. lamps, 20 lamps. These figures are said to be unofficial, but the journal in question considers that they have sufficiently good authority to warrant publication. The penalties fixed for infringement of the rates are heavy, and should keep the various firms in line as regards price. The competition thus will be only on the ground of reliability and efficiency. On the whole, the public are likely to gain by the uniformity of price if no further increase is decided on. With incandescent lamps the cost of manufacture per lamp sold is largely a matter of selection of the best and of destroying a certain number of imperfect lamps. Hence makers of no repute can net a large profit in a short time by selling the bad lamps with the good ones at a low price. Such a practice should be stopped by the uniform rate.

Helium and Argon.—It is reported that Prof. W. Ramsay and Mr. J. Norman Collie have by fractional diffusion through porous tubes separated argon into two portions, of which the lighter has a density of 19·93, and the heavier of 20·01. Similar experiments with helium gave densities of 1·874 and 2·133 for the two extreme portions, results which were confirmed by measurements of the refractive indices by Lord Rayleigh. The result is interesting, though not unexpected. Considering, however, that by the method employed not even an approximation to purity is obtainable there does not seem much justification for an eminent scientific contemporary outraging dynamics with the remark that since apparently identical spectra are obtained from both the heavier and lighter portions of the gases, "the possibility is suggested of there being here a true separation of light molecules from heavy molecules of the same substance." In spite of its characteristic spectrum the spectroscopists absolutely failed to discover the argon they were breathing every day until the chemists separated it and gave it them in a tube, while as to helium, though they named, numbered, and wrote magazine articles about it, they were quite unable to find any of it nearer than ninety million miles from South Kensington. Under the circumstances one would have expected the exponents of spectroscopic methods of research to have kept very quiet for a time. With regard to argon, providing it has a two-atom molecule, it may reasonably be expected to consist of three gases of nearly the same weight and very similar properties, and of which two would be much less common than the third. Hence the difficulty of separating them. The same may be true of helium, but the inference, which is at best only an empirical one, is less strong. If the molecule is really monatomic, one of the two constituents ought to have nearly double the atomic weight of the other. Finally, it may be said that from researches by Mr. Siegfried Friedländer, published in the *Zeitschrift für Physikalischen Chemie*, it appears that there is a minute proportion—perhaps, a thousand-millionth—of helium present in air, and that under prolonged electric action both argon and helium are at any rate absorbed by platinum, if they do not really combine with it.

Mechanical Stokers.—The New York *Electrical World* believes that the many recognised advantages possessed by the automatic mechanical stoker over the ordinary methods of hand firing have failed to make its adoption more general principally for the reason of its high first cost, cost of repairs, and the necessary attendance required for its successful operation. In a paper read before the St. Louis meeting of the American Society of Mechanical Engineers, Mr. Whitham has given the results of numerous tests on three typical types of mechanical stokers with rocking and chain grates and adapted to the use of the cheapest grades of anthracite and bituminous coals. Mr. Whitham points out that a saving of 40 per cent. can be effected in plants of 500 h.p. using mechanical stokers and provided with coal-handling machinery. Although such stokers do not develop a capacity equal to the hand-firing methods, they are more constant in the power developed and readily respond to large fluctuations in load. They may be characterised as being always in the condition of a hand fire immediately after cleaning. Such working naturally tends to a longer life of the boilers. By employing mechanical stokers the

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poorest grade of coal may be used without smoking, and at the same time with economical combustion. They, however, require power for their operation, which may be either an electric motor or small steam-engine. Moreover, practically all stokers require a strong draught, either natural, induced, or forced, and this adds another item of cost to that of operating. If a steam plant be used, this will require from 5 to 11 per cent. of the total amount generated, whereas a fan blast requires from 3 to 5 per cent. A steam blast, when used as an aid to combustion, produces an exceedingly long flame, which results in obtaining a more uniform heating surface, and causes a more uniform expansion throughout the boiler than can be obtained by short flames, having a more or less local application. Clinkers are at the same time avoided, and the grates have a longer life. When the demand upon the boiler is not severe, it has been found preferable to shut off the steam blast when such is employed; but care must be exercised to prevent undue heating of the grate. In stations requiring a graduated air blast, still greater care is necessary to regulate the amount of air admitted.

Li at Greenwich and Elsewhere.—Last Friday morning His Excellency Li Hung-Chang went to the Telegraph Construction and Maintenance Company's Works at Greenwich, as per programme. The usual order was reversed, and the telegraphing was done before luncheon instead of after it, so that the Chinese end had not to stay late for the messages after all. Li, however, did not get on to Pekin, the Chinese Internal Telegraph Administration apparently not being propitious, but the Eastern Extension Telegraph Company, in conjunction with the Great Northern Telegraph Company, put him on to Shanghai and Tien-tsin. Transmission to Madras was done in two and a half minutes, which is a record for the Eastern Telegraph Company. It took 10 minutes longer to transmit to Shanghai. His Excellency seemed mainly anxious to know the precise whereabouts of a certain Lord Shen. It is noteworthy that in the replies from China Li was given his proper style, which is not usually done here. Also he was not troubled with the difference between English and Chinese time. He is an extraordinary man, and doubtless when he goes back will find out that his messages were received in the evening. Meanwhile, various stations along the route telegraphed their weather. It was fine at Malta (it always is) but damp at Alexandria, which is not in accordance with the fitness of things. However, as Li Hung-Chang is not going back that way he probably did not care. During the week he has gone north and has been saying complimentary things about steam, electricity, and English philosophy. He got rather mixed in his list of English philosophers, but that is excusable. Other people have done the same before, and some Germans have gone so far as to say there are none. But on science and engineering he was very strong. English science, he says, is too exclusively practical, and Chinese too abstract, but it only requires that they should be brought into conjunction, and the greatest results may be expected. If His Excellency wants to see what we can do in the way of keeping down practicience (this is according to rule) and cultivating abstractivity he might consult some of our mathematical writers on electrical theory. He knows English, though he chooses to talk with an interpreter—that discovery was made at Greenwich—and a man who has asked a lady her age, a journalist his salary, and a director the amount of his holding of ordinaries, all in one week would obviously not be afraid to tackle anything.

Contact Resistance.—Mr. Charles West has made an interesting contribution on the subject of contact resistance to our New York namesake, the *Electrical Engineer*. He emphasises the great difference in the contact resistance between surfaces at rest and in motion, and refers to some experiments carried out by himself in the Edison Laboratory. In this instance, the experiments were conducted on surfaces at rest, and the following were the conclusions arrived at: with pressures between 25lb. and 250lb. per square inch resistance varies nearly inversely as the pressure; the total pressure remaining constant, reduction of area does not alter resistance within wide limits; pressure and area remaining constant, variations in the perfection of fit between the surfaces produces slight, if any, change in the resistance; clean petroleum oil placed between the contact surfaces does not greatly alter the resistance; clean petroleum oil mixed with pure graphite to the consistancy of cream does not greatly alter the resistance; a washer of thick tinfoil (pure tin) interposed between the contact surfaces gave a total resistance for the double contact not greater than the single contact of the blocks with each other, except with the lighter pressures. No time tests were made. During the experiment the two surfaces were fitted until the lower block could be lifted by the upper block by suction. Ordinary care was taken to exclude dust. The slight effect of oil on the resistance is surprising, as with well-fitted surfaces and only moderate pressure it might be expected that a continuous film of oil would interpose between the plates. It would appear that actual contact between the surfaces with moderate pressure, even with well-fitted surfaces, is at a few points only; that increase of pressure brings more points into contact in proportion to the pressure; also that the actual points of contact are able to displace the liquid film. The author concludes that large surface of contact is of value, in switches for instance, for giving increased radiating surface and proper conductivity without undue pressure per unit of surface area—that is to say, in switches while conductivity might be secured with less surface than is now the usual practice, under sliding motion such pressure would give increased tendency to cut. In 'bus-bar joints, and similar cases of joints carrying large currents, where the conductors are ample, if a heavy pressure can be secured and maintained, the area of contact may safely be reduced to the amount required by mechanical considerations. It is also probably true that in such joints the interposition of a washer of pure tin, not too thick, is of advantage in protecting joints from the effects of corrosion.

Electricity in the Coal-Mine.—At the meeting of students connected with the Federated Institution of Mining Engineers, at Leeds, the principal business was the discussion of a paper by Mr. Roslyn Holiday on "The Application of Electricity to Mining Operations." Mr. Holiday, in the course of his paper, stated that in mining operations there were hardly any uses to which power was transmitted by hydraulic, pneumatic, or mechanical agency to which electricity could not be applied. The principal question, however, was whether it could be applied more economically than other forces, and without endangering the lives of the men. Whether it was economical to use electricity depended to a large extent on local circumstances. Among the advantages of electricity were its adaptability to a variety of purposes and its portability. The first use to which mining engineers applied electricity was in the pumping of water, and though that was not the kind of work in which it showed to the best advantage (except in the case of dip pumps), still, the advantage of having a pair of cables and a column of pipes fixed in the shaft instead of a lot of moving spear-rods was evident. As regards the underground haulage, it would be hard to find anything to beat in economy an engine on the surface driving a rope which was carried down the shaft,

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In the driving of underground fans electricity could be advantageously applied. The great drawback to the use of electricity in mines, especially at the working face, was the liability to "sparking." No continuous-current motor had been made which had not a commutator, and to render those machines safe the expedient of completely boxing them in had been resorted to. There was, however, the alternating motor of the polyphase type, in which there were no commutator. That machine, if electricity was to be used at the coal face for cutting and drilling, was, in the writer's opinion, the most suitable one. A combination of dynamo and motor should not involve a loss of more than 10 to 15 per cent. of the total power delivered to them. The Chairman (Mr. G. A. Mitchell) remarked that the first cost of motors was greater than that of steam-engines and pipes. Mr. F. E. Parrington, Wearmouth Colliery, Sunderland, said there was a disadvantage in alternating motors, as they pulled up when very slightly overloaded. Mr. Bell, also of Wearmouth Colliery, said that in the Durham and Newcastle coalfields there were not three collieries where electricity was used as a motive power. If sparking occurred in the return airway the results would be disastrous. There is always a disposition to stand in old ways, but if sparking is the only difficulty in the way of electric working in the coal mine, that can be got over without waiting for the coming of the commutatorless continuous-current motor. It has been looked for in America, but it is considered wiser not to go hunting a will-o'-the-wisp.

Electric Dredger.—Some time ago we briefly noted the construction of an electrically-driven dredger for Mr. P. Bunau-Varilla, who designed to use it for the purpose of fetching up ballast from the bed of the River Esla for the new railway between Plasencia and Astorga. This dredger and its work has formed the subject of a descriptive article by Mr. Felix Boix in the *Revista de Obras Publicas*, and an excellent process print is given of a photograph showing the dredger at work. The article is much too long for reproduction in these columns, but some additional particulars beyond those we have been able to give before may be noted. The generating station contains a 150-h.p. horizontal com pound engine, which can be run either with or without condensing. Steam is supplied by a cylindrical boiler with copper tubes. The generator is a belt-driven triphase machine, giving current at 2,000 volts (alternating). There is a switchboard and the usual accessories, and the current then goes to the dredger by an overhead line with bare copper wires for the land portion and a highly insulated cable through the water. The dredger is a bucket one of an exceptionally substantial type, and is constructed of iron and mild steel. On reaching the dredger the current is transformed down to 200 volts and distributed to the various motors, These consist of a 45-h.p. Brown motor running at 600 revolutions a minute and used to work the bucket drum, and another 10-h.p. motor of the same speed, which works a centrifugal for washing the ballast as it comes from the buckets. Besides these, in the after part of the dredger, there are two 25-h.p. motors working screw propellers. The dredger will work to a depth of about 23ft. The buckets are steel lipped, and the inclination and, consequently, the depth of dredging, is determined by a cable winding on a drum. This latter is worked by a 15-h.p. motor, which for a charge is run at 800 revolutions, all the other motors going at 600. The method of gearing down is not stated, probably in this case it would be a worm gear. In this respect details are wanting as to all the motors. The dredger is expected to excavate about 144 cubic meters per hour, or more than 1,500 loads of ballast for a 10-hour day. Various advantages are claimed for an electrically-driven dredger over one of the ordinary steam type, but of these the most important appears to be the removal of the weight of the steam-engines, boilers, and coal stock from the dredger to the central station. As for excavation work by means of a floating dredger a fleet draught for the latter is of the essence of the business, the importance of removing all unnecessary weight is evident. Finally it remains to be said that the dredger was constructed by A. F. Smulders, of Rotterdam, from the designs of Mr. Bunau-Varilla; the electric work was done by Brown, Boveri, and Co., of Baden (Switzerland). The dredger was put together and tried on the Maas in the presence of the principal engineers of the Dutch Waterstaat, and worked well. How she has been got out to Spain across the Bay is not known to us.

Rontgen Rays in Surgery.—Dr. H. Lewkowitsch has an article in last week's *Lancet* on a new method for the application of Röntgen rays in ophthalmic surgery with the view of detecting the presence of foreign bodies in the eye and determining their position. Ordinary light and the ophthalmoscope give no help when the foreign body is very small, or when it is embedded in the non-transparent tissues of the eyeball, or where a large extravasation of blood obstructs the view of the fundus of the eye, and where the cornea has become impermeable to light; and the magnet is useless for anything but iron. For such a case as finding the position of a small piece of glass, Dr. Lewkowitsch considers the Röntgen rays method applicable, and he has experimented on dead eyes and (so far as possible) on himself. There is no need to go into surgical details, but the main difficulty is, of course, that the eye is surrounded by a bony case. The difficulty is got over by a special form of plate capable of being "inserted into the orbital cavity between the os lacrymale and the eyeball." Of course, this is done under cocaine anæsthesia. Mr. R. Barwell contributes an article to the same journal on the use of the Röntgen rays in determining the proper treatment in the case of congenital deformity of the feet. While on this subject it may be mentioned that at the meeting of the British Medical Association at Carlisle Dr. J. Macintyre gave a demonstration of the means by which he had obtained results in his attempts to photograph and see on screens the deeper-seated structures of the body. He first pointed out that in photographing the lower animals he had got fairly satisfactory shadows of certain organs within the cavities. Proceeding to make a series of experiments he had found, contrary to expectation, that greater currents were required. One might have thought that if photographs of the bones were to be got with certain apparatus in a given time then by diminishing the exposures it might be possible to catch the soft tissues before they disappeared. This proved not altogether true. In the centres, particularly the heart, the tissues were dense, and for these it was necessary to use large currents. He could photograph the spine and omit the heart and sternum, and, on the other hand, the latter could be got and the spine omitted. The limits of the pleural cavities, the heart in movement, the diaphragm in action, enlargement of the heart, liver, etc., had all been seen. A case of renal calculus photographed and since successfully operated upon was described. At Munich, where, as we noted last week, a good deal of fuss was made over some similar experiments, they appear to have since gone on to talk nonsense about "cosmical vital force." Those sort of things will happen at an international congress of psychology, but it is disappointing all the same, because it was from Munich that the first results came of attempts to measure wave-lengths beyond the ultra-violet.

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THE 1896 MEETING OF THE VERBAND DEUTSCHER ELEKTROTECHNIKER IN BERLIN.

(BY OUR SPECIAL CORRESPONDENT.)

(Continued from page 120.)

Interview with Mr. H. Gorges.

I was introduced to the above-named gentleman after the Saturday's meeting of the Verband. He had then just been reading his paper on the methods of varying the speed of rotating field motors. His name has appeared at the head of so many important additions to the knowledge of theory and practice of alternating-current apparatus that his opinions are valued most highly. Mr. Görges kindly promised to grant me an interview and to show me the works of his firm, Messrs. Siemens and Halske. I gladly availed myself of this promise early in the following week. At the works I had a struggle with the *portier*, to whom I at last managed to explain in German what my business was. He then used the telephone and mutilated my name to somewhat the same extent that I had previously injured his native tongue. Mr. Görges kindly sent one of his staff to conduct me to his office, which is situated some distance from the general offices of the firm. On the occasion of the Verband visiting the Berlin Exhibition, as mentioned elsewhere, we were allowed to travel gratis on the electric line equipped by Messrs. Siemens and Halske to carry the public from the heart of Berlin to the exhibition. I was then much impressed with the power of the motorcars, which had two trailing cars attached. In answer to my queries, Mr. Görges informed me that the overhead part of the line from Lindenstrasse to the exhibition was about 4½ miles long, and at the city end there is about another mile of conduit work. The same cars run the full length of the track, the collecting gear only being altered to suit the system of supply. The speed of the cars varies considerably with the nature of the street, but after leaving Berlin there are several long runs over which an average speed of 12 miles an hour is maintained. My impression is that the maximum speed is something over 20 miles an hour. There are two motors on the front cars, each of 12 h.p. nominal, but this power is reckoned at the speed of eight miles per hour, and not by multiplying the starting torque into the maximum speed, as is too often done. The lines have been equipped under a two years' concession, but it is likely that the public will object at the end of the time to having the track pulled up and their convenient means of travelling removed. The motorcar and two trailers are capable of carrying some 100 passengers without crowding.

We then left the subject of electric traction for that of alternate currents and the polyphase systems. Siemens and Halske find that of their annual output of electric generators and motors, about two-fifths of the total power is for work on the polyphase systems. The three-phase system is almost always used in preference to the two-phase on account of the advantages the three-phase motors have over their duplex rivals. The latter system has, however, some advantage, in Mr. Görges's opinion, where many lamps have to be supplied, as individual groups do not affect the whole. Still, with well-designed three-phase generators there need be no trouble. The great aim in the design in such cases is that the reaction in the armature of the generator shall be small. Thus, in Chemnitz, Messrs. Siemens and Halske have installed a complete three-phase system with transformers, and a difference of more than two volts between the different phases is not found under any ordinary conditions. Messrs. Siemens and Halske have also recently designed a 1,000-h.p. plant for transmission of power in Guatemala with similar conditions. The voltage adopted in this case was 10,000, and the power will be employed for lighting and driving small motors.

If the tramways care to take the supply rotary transformers will be used. I found that Mr. Görges supported the practice of using synchronous motors, as is done on the Dublin-Dalkey line.* He thinks that the advantage of having a power factor of unity, and saving some 10 to 15 per cent. in the current transmitted in the high-tension feeders, for a given power warrants the adoption of the synchronous motor rather than its lagging *confrère*. Still, in some cases where the starting devices cannot be conveniently applied, he has used the non-synchronous motor for the above purpose.

I then asked Mr. Görges's opinion of a statement made to me before leaving for Germany that no Continental maker could make a single-phase motor to start under full-load torque. He assured me that his firm manufactured a large number of such single-phase motors which will start under full-load torque and only take 2½ times the full-load current. If, on the other hand, the current is kept down by suitable arrangements to the normal full-load value, the starting torque is about half that at full load. The starting gear used consists of a combination of resistance and induction coils. The efficiency of these single-phase motors is not so high as with the polyphase ones, ranging from 6 to 10 per cent. less. Thus the efficiency of the polyphase motor manufactured to Mr. Görges's designs varies from 80 to 85 per cent., according to the size of the motor. The single-phase motors have, on the other hand, efficiencies from 70 to 78 per cent. All these figures are for a frequency of 50 complete periods per second, which is the standard frequency throughout Germany. This frequency has been found to be the best for general purposes, but for transmission work only Mr. Görges prefers a lower periodicity. He stated that a rise of frequency considerably increases the leakage drop of a transformer. The reason of this at first is not obvious, as with the lower frequency a higher induction is used. This higher induction means a higher value for the magnetic potential, which will give a slight increase in the leakage from the iron. This leakage from the iron is not, however, the chief cause of the magnetic drop. Mr. Görges explained that the leakage is due rather to the induction in the space between the two sets of coils. (The core type of transformer made by Messrs. Siemens and Halske is not unlike that manufactured by Messrs. Johnson and Phillips, in England, and has the primary and secondary coils wound on concentric cylinders.) In this space the magnetising force is thus produced by the sum of the ampere-turns in the primary and secondary coils, and hence the induction reaches an appreciable value, although the medium is air. Now, if a high frequency is used, the induction in the iron is lowered, and the proportion between these leakage lines and the lines through the iron therefore is increased. This increases the drop appreciably. The effect is magnified if the transformer is used for high voltages, which necessitates a large air-gap between the primary and secondary windings. For this and other reasons, Mr. Görges prefers a frequency of 30 ∿ for transmission work only. We then agreed to disagree over the question of the effect on a motor of this reduction in frequency. Mr. Görges stated his case thus: With the lower frequency you can get more output for a given weight, because you can use a larger induction in the iron. Also you save copper. I submitted that if the output of the motor was limited by its rise in temperature, you reduce the output by lowering the frequency because the hysteresis loss is increased. On the other supposition, that the output is limited by the armature reaction causing a drop in voltage, the lowered frequency will again lower the output. We agreed, finally, that the lower frequency gave more mechanical designs for ordinary speeds of the motor, and also a larger proportion of iron per total weight.

Mr. Görges then kindly showed me over the works, and we were thus able to examine several of the machines we had been conversing about. I was especially interested in the core-stamping department. The accuracy of the armature plates turned out from this department is wonderful. The number of automatic and self-feeding punching machines enable the work to be turned out economically. The plates, when put together to form armatures or field-magnet systems, present a surface which looks as though it had been machined.

The starting device much used in these works for reducing the starting current of polyphase motors is shown diagrammatically in the adjoining Figs. 1 and 2. The

* *Electrical Engineer*, vol. xvii., page 537.

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armature is provided with two circuits for each limb of the three-phase system. These two circuits are different both as to the number of turns and resistances. In starting, as in Fig. 1, the E.M.F.'s induced in each circuit of each limb oppose each other and the acting E.M.F. is the difference between that in each of the two circuits. The current is,

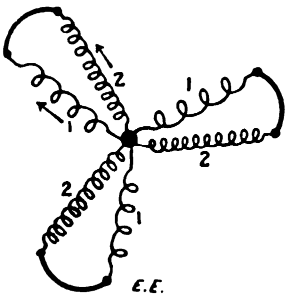

FIG. 1.—Starting Connections for Armature of Siemens and Halske's Three-Phase Motor.

of course, also proportional to the resultant E.M.F. When the ends of each limb are permanently connected together, as is the case when running (Fig. 2), each circuit can act independently, and the effect is therefore increased nine times if the ratio of the turns in each of the parallel circuits is 2 to 1. The short-circuiting of the ends is easily effected

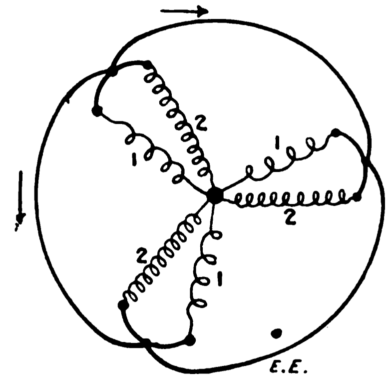

FIG. 2.—Running Connections for same Motor.

by a lever at one end of the motor working on an attachment similar to that used in the steam-engine governor.

The method used in the works of measuring the power given to three-phase motors is that due to Prof. Frölich. The connections used are shown in Fig. 3. The apparatus consists practically of three coupled Siemens dynamo-

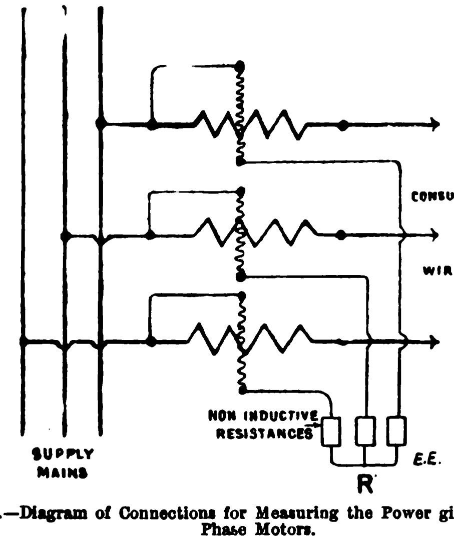

FIG. 3.—Diagram of Connections for Measuring the Power given to Three-Phase Motors.

meters. The three thick wire coils are placed in series with the wires supplying the motors, and the thin wire coils are connected through non-inductive resistances to a common terminal. The instrument so connected gives the total power delivered to the motor, and is independent of any variation in either circuit.

(To be continued.)

RAILWAY BLOCK SIGNALLING.

BY J. PIGG.

(Continued from page 149.)

WALKER'S BLOCK INSTRUMENT.

The external appearance of this instrument is shown by Fig. 3. The connections for a block section are shown by Fig. 42, and further details of the mechanism are given by Fig. 42A. Details of the construction of the signalling key are given by Fig. 43. The upper electromagnets work the white arm, and the lower work the red arm and bell. The current passes through the upper coils at the home station, and through the lower coils at the distant station. The signalman at any station, therefore, works the white arm at his own station, and the red arm and bell at the distant station simultaneously. The signalling key is simply a current reverser. The upper, or white, knob sends a current through the upper coils

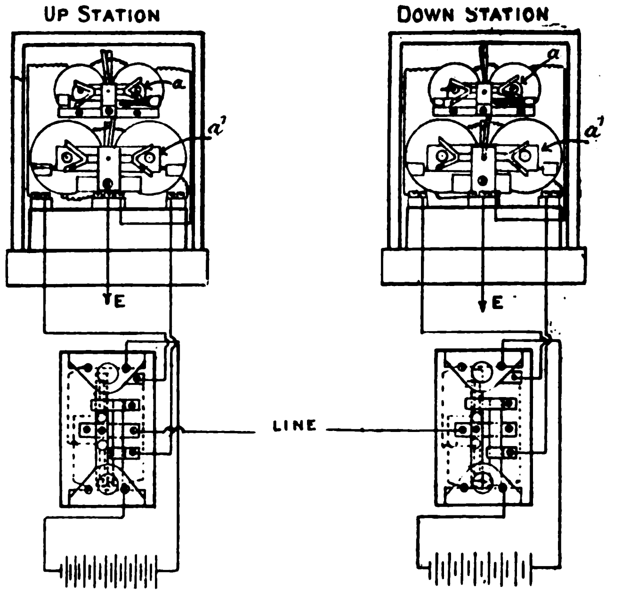

FIG. 42.—Double-Line Block Circuit—Walker's Instruments.

at the home station, earth, lower coils at the distant station, line, to zinc at the home station. The result is to raise the white arm and red arm at the home and distant stations respectively, and the bell at the latter place is also rung. The lower or black knob reverses the direction of the current and lowers the arms at the two stations and also rings the bell at the distant station. Both sets of electromagnets actuate polarised and non-polarised arma-

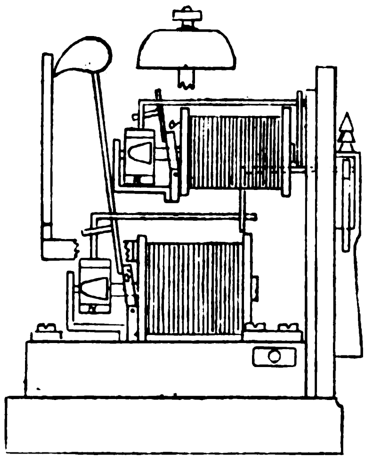

FIG. 42A.

tures. The V-shaped permanent magnets actuate the arms when a current passes in the proper direction. The non-polarised armature, *a*, of the upper electromagnet locks the polarised armature in position. The non-polarised armature, *a'*, of the lower electromagnets carries the bell hammer, and also locks the polarised armature in position.

It will be noticed that descriptive signals must be given by a bell code; and, also, since the bell is rung by the

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depression of either of the two knobs of the signalling key, either would serve for sending train-distinguishing signals by bell code if there were no other considerations to take into account. The particular knob to be used at any time, however, depends entirely on the indications exhibited by the instruments. Thus, suppose a train to be in the section on the "down" line and a train is to be signalled on the "up" line. The signalman at the sending end for the "up" line must give any bell signals on the white knob, or he will lower the arms, representing the condition of the "down" line. On the other hand, the signalman at the receiving end for the "up" line must acknowledge bell signals on the black knob, or he will raise the arms representing the "up" line prematurely. If there are no trains in the section, bell signals are given and acknowledged on the black knob. The position of the arms is horizontal when trains are in the section; when no trains are passing the arms are lowered. There is, therefore, no indication corresponding to "Line clear" or section ready for train to enter with this form of instrument.

Preece's Block Instruments.

Another form of block instrument for use with transient currents and one line wire is shown by Fig. 44, which represents, diagrammatically, the connections for a block circuit using Preece's block instrument. In this form of instrument the indicator for approaching trains is of a different form to that for receding trains, in addition to being in a different position on the face of the instrument. The "on" "off" disc at the upper part of the instrument is the indicator for trains passing *from* that station; the semaphore arm is the indicator for trains *approaching* that station. The disc indicator at the sending station is practically a repeater for the semaphore arm at the distant station, in that its movement shows that the actions of the signalman at the distant station have been such as are calculated to lower the semaphore arm at that place. The position of the disc is "on" and the corresponding position of the semaphore indicator is horizontal, both when trains are actually passing through the section and when it is clear of trains, but the difference between these conditions is indicated, where a three-position switch is used, by the switch handle being placed in the position marked "Train on line." There are thus, practically, three different indicators in this form of instrument. Diagram Fig. 44 is drawn to show "Line clear" for a train ready to proceed from the "up" station to the "down" station. The handle of the switch, C, occupies the "off" position shown at the "down" station during the time the "Line clear" signal is being exhibited only.

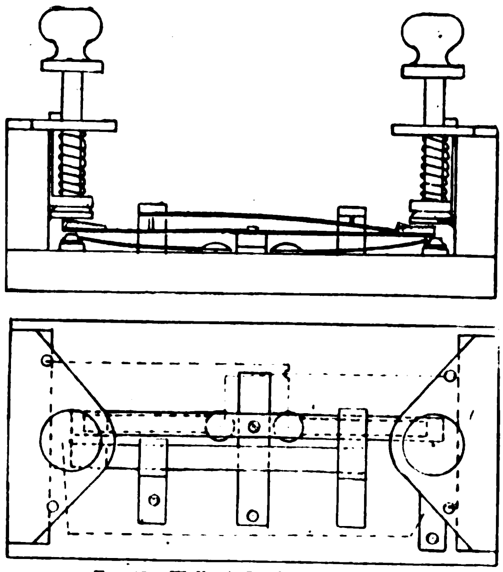

Fig. 43.—Walker's Double-Current Key.

The construction of the instrument presents several points of interest in the methods adopted to ensure efficiency. The disc indicator is actuated by the polarised armature of M_1, and the bell is worked by a non-polarised armature on the same electromagnet. The position of the disc depends, therefore, on the direction of the last current passed through M_1, whilst the bell is rung by all currents passing through that electromagnet. The currents passed through M_1 are from the local battery, and their direction depends upon the position of the switch, S, at that place. The semaphore arm is held in a horizontal position by the detent, *l*, attached to the non-polarised armature of M_2, and also by the forked lever, *g*, which rests saddlewise on the bar connected with the polarised armature of M_3. There are thus two electromagnets to actuate before the semaphore arm can be lowered, and these must be acted upon in a prearranged order. In addition to the polarised armature, N, M_3 actuates a non-polarised armature, which completes two local circuits each time a current passes through M_3. One local circuit is through M_4, and serves to magnetise the armature, N, and the cores, S, of M_3, the direction of magnetisation depending upon the position of the switch. The electromagnet M_2 is short-circuited when the polarised armature of M_3 occupies the position shown at the "up" station, and is not, therefore, affected by currents when the switch is in the "on" position. If the switch at the "up" station, say, is put into the "off" position, and the plunger, K, is depressed, a current will pass *viâ* earth, M_3 at "down" station line, short-circuit of M_2 at the "up" station, and the switch lever to zinc. This current operates the two

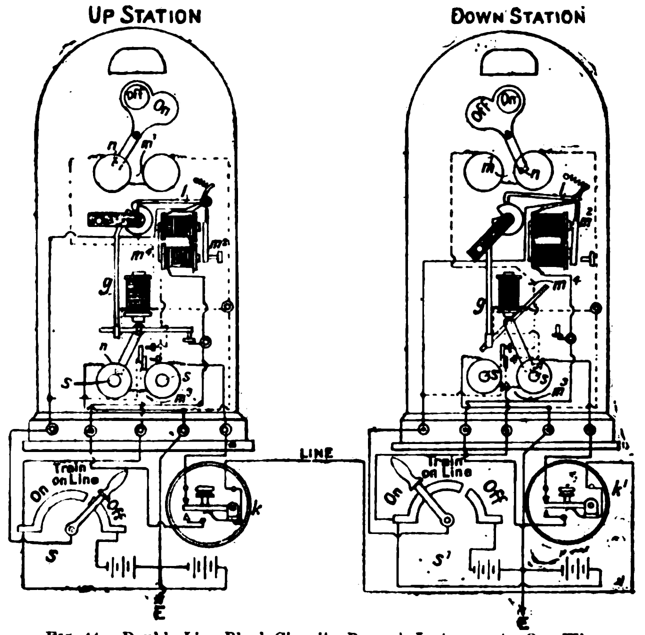

Fig. 44.—Double-Line Block Circuit—Preece's Instruments, One Wire.

local circuits at the "down" station by the non-polarised armature of M_3. One local circuit rings the bell and the other magnetises the polarised armature of M_3, and causes the latter to take up the position shown. The forked lever, *g*, is released, but is still held in position, together with the semaphore arm, by the detent, *l*. The movement of the polarised armature of M_3 to the position shown at the "down" station breaks the short-circuit of M_2. If the plunger, K, at the "down" station is depressed in reply, a current is sent *viâ* M_2 at the "down" station, line, and K, M_3 at the "up" station, and earth to zinc at the "down" station. M_3 at the "up" station closes the local circuits and moves the disc indicator to the "off" position. The instruments are then in the position shown, which indicates "Line clear" for a train to pass from the "up" to the "down" station. When the "Train on line" signal is to be sent, the switch at the sending end is put into the appropriate position and the plunger depressed. The current being in the opposite direction to that for "Line clear," attracts the polarised armature of M_3, and through the forked lever, *g*, raises the semaphore arm, where it is again caught by the detent, *l*. The reply signal to the "Train on line" causes the disc indicator to occupy the "on" position, since the direction of the local current has been altered by placing the switch to "on."

It will be noticed from the diagram that the switches when in the "Train on line" position do not affect

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the currents sent from the home station in any way different from those produced when the switches are in the "on" position, and the clearing bell signals may be given and acknowledged with the switches in either of these positions. The difference between the "Line closed" and "Train on line" indications are merely shown by the position of the switch lever for the signalman's information. It will be further observed that the obviously most important signal of "Line clear" can only be exhibited by concurrent action on the part of the signalmen at the ends of the section, and unless the actions

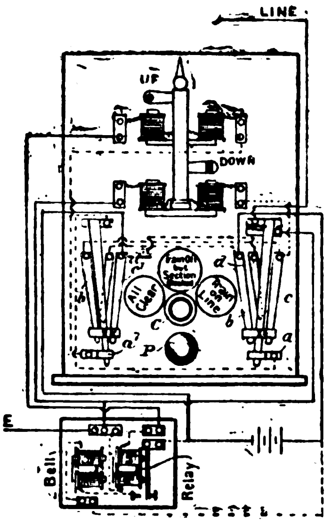

FIG. 45.—Harper's Single Plunger Block.

are carried out in proper sequence no such signal will be exhibited. The semaphore arm at the receiving end is lowered by the direct action of the signalman there, but only after his instrument has been prepared, so to speak, by the action of the signalman at the sending end, and the same action notifies the sending end of what has been done independently of the bell signal. On the other hand, the semaphore arm is raised by the direct action of the signalman at the sending end when the "Train on line" signal is sent.

Harper's Block Instrument.

A further example of a single-wire block instrument is shown by the diagram Fig. 45, which represents Harper's form of instrument. There are in this instrument two different forms of indicator; the lettered discs seen near the bottom of the instrument show what signal has last been *sent* for one line, and the semaphore arms indicate what signal has last been received for the other line. The movement of the discs into their proper position alters the direction of the current through the electromagnets at both stations. These currents are sent by the depression of the plunger at the bottom of the instrument. When the dies "All clear" is being shown, the plunger depresses the long spring on the right hand, breaking contact with *a*, making contact with *d*, and completing the circuit between *b* and *c* by the insulated cross-piece, *h*. The current passes by *b c*, and the lower electromagnet at the home station to earth, the relay, the upper electromagnets, a_1, left-hand spring, *a*, and right-hand spring, at the distant station, line, right-hand long spring, *d*, and zinc at the home station. When the disc indicator is in the position shown, or indicating "Train on line," the left-hand long spring is depressed by the plunger, and the direction of the current is reversed. Since the bell is rung by a local current, the circuit of which is closed by a non-polarised relay, it is obvious that the bell will be rung at the distant station at every depression of the plunger at the home station. Currents passing through these instruments actuate the lower electromagnets at the home station and the upper electromagnets at the distant station, and, since the position of the disc indicator controls the direction of the currents, it follows that the disc indicator at the home station must be set to the appropriate position before the signal can be given. The positions of the semaphore arms are in accordance with the signals *sent* and *received* respectively for the lower and upper semaphores, and by their position represent the character of the indication exhibited by the disc indicator at the distant station, in so far as the difference between the "All clear" and the "Train on line" or "Train blocked" signals is concerned, but do not indicate the difference between the two last-named conditions of the line. Obviously the difference between the "Line blocked" and "Train on line" indications at any one station exercises no influence on the character of the indications at the distant station.

Fletcher's Combined Block.

Fig. 46 is a diagram showing the connections for a double-line block circuit with Fletcher's block instrument. In this form the bell-signalling apparatus is entirely distinct from the indicating apparatus, and three line wires are required. The indicators show "Line clear," "Train on line," and "Line closed" by the different positions of one indicator. The "Line clear" and "Train on line" indications are maintained by continuous currents. "Line closed" is indicated when no current is passing. All currents pass through the lower electromagnet at the home station and the upper electromagnet at the distant station. If the commutator at the "down" station, say, is turned to the left, the springs, *a* and *b*, *c* and *d*, are connected, and a current passes to earth at the home station, through the upper electromagnets at the distant station, the line, the lower electromagnets, and the springs, *d* and *c*, to zinc at the home station. If the commutator is turned to the right the direction of the current is reversed, the springs *a* and *d* being connected, and also the springs *b* and *c*, and the character of the indication exhibited is altered accordingly.

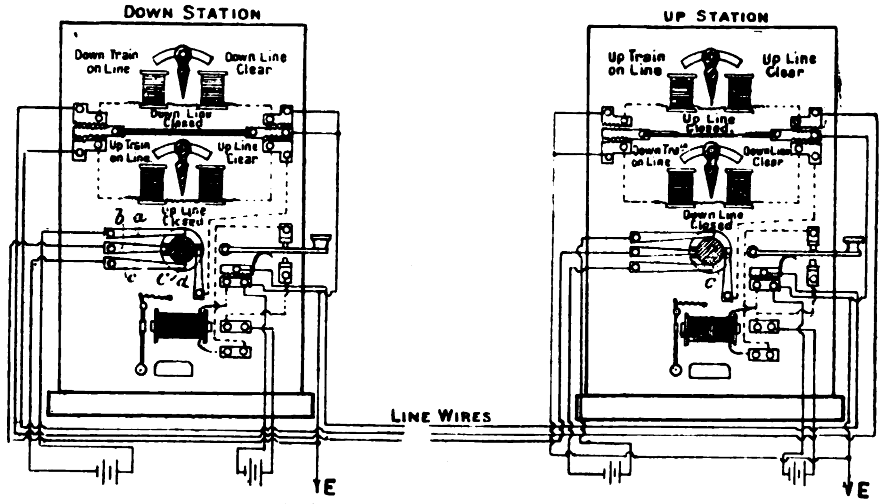

FIG. 46.—Fletcher's Combined Block, Three-Wire. Diagram of Connections for One Section.

Tyer's Semaphore Block Instrument.

The instrument shown in diagram, by Fig. 47, is Tyer's

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semaphore block. In this form of instrument the signals are sent by the plunger, P, and the direction of the currents is controlled by the position of the commutator, C, which also carries the disc indicators "Line clear" and "Train on line." Currents pass through the lower electromagnets at the home station, and the upper electromagnets

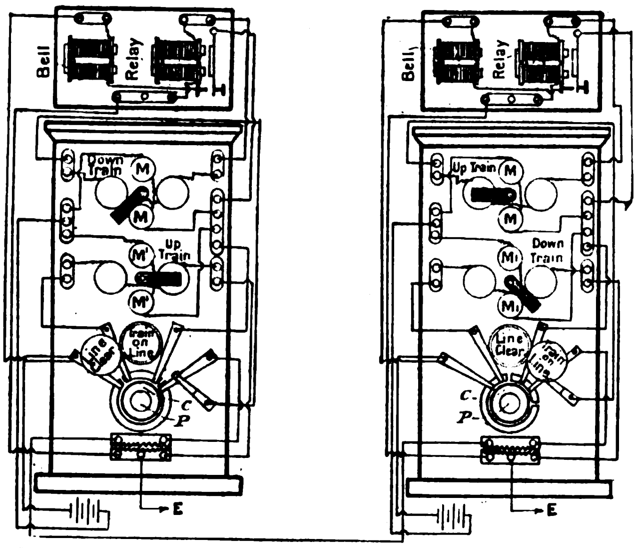

FIG. 47.—Double-Line Block Circuit—Tyer's Semaphore Block Instruments.

at the distant station. The upper magnetising coils, M, are brought into use by the relay: the lower magnetising coils, M_1, are traversed by the currents sent from the home station. As shown in the diagram the instrument makes no distinction between "Train on line" and "Line closed," but in later instruments this distinction is made.

(To be continued.)

THE PRINCIPLES OF ALTERNATE-CURRENT WORKING.*

BY ALFRED HAY, B.SC.(EDIN.), A.I.E.E.

(Continued from page 185.)

45. We shall next consider the distortion of shape produced in a simple harmonic wave by the superposition on it of a third harmonic. The shape of the resultant curve will depend very largely on the phase relation of the two curves. If the two curves are coincident in phase when the fundamental harmonic passes through its zero value, as in Fig. 36, the resultant curve is flattened at the top.

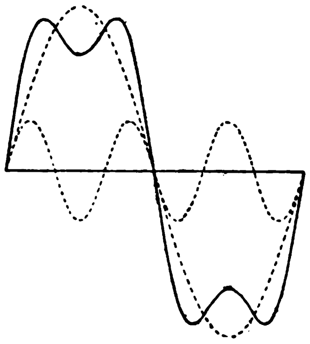

FIG. 36.

If, on the other hand, the two curves are in opposition as regards phase, as in Fig. 37, the resultant curve runs up to a sharp peak. In both cases each half-wave is symmetrical about a vertical line bisecting it. Again, if we take an intermediate phase relation, such as that shown in Fig. 38, there is no longer any symmetry about a vertical axis, and the general shape of the resultant curve is intermediate between those of Figs. 36 and 37, the curve being flattened in one part and peaked in another.

It is found that most alternator E.M.F. curves may be represented, with a considerable degree of accuracy, by the expression

$$e = A_1 \sin pt + B_1 \cos pt + A_3 \sin 3pt + B_3 \cos 3pt + A_5 \sin 5pt + B_5 \cos 5pt. \quad (26)$$

We shall therefore assume that all the curves with which we have to deal may be resolved into the above harmonic terms. The problem, then, of analysing the curve harmonically is reduced to the determination of the

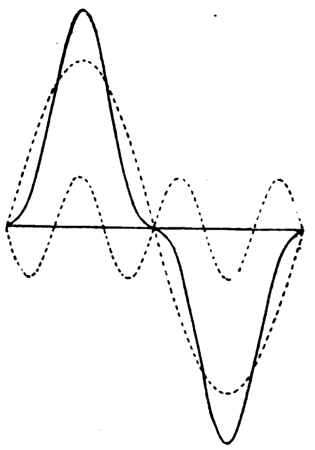

FIG. 37.

coefficients, A_1, B_1, A_3, B_3, A_5 and B_5. This may be effected as follows:

Taking the zero value of the E.M.F. as our starting-point—*i.e.*, as the point at which $t = 0$—let us divide a *half-*

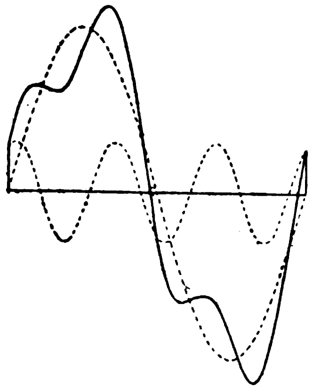

FIG. 38.

period into six equal parts. The values of pt corresponding to the first six points of division, including the starting point, are

$$0, \frac{\pi}{6}, \frac{\pi}{3}, \frac{\pi}{2}, \frac{2\pi}{3}, \frac{5\pi}{6} \text{ radians,}$$

or $$0°, 30°, 60°, 90°, 120°, 150°.$$

From the E.M.F. curve we can read off the corresponding instantaneous values of the E.M.F. Let these be

$$0, e_1, e_2, e_3, e_4, e_5.$$

Then, remembering that $\sin 30° = \frac{1}{2} = \cos 60°$, and $\cos 30° = \frac{\sqrt{3}}{2} = \sin 60°$, we have, by equation (26),

$$B_1 + B_3 + B_5 = 0 \quad . \; . \; . \; . \; . \quad (a)$$

$$\tfrac{1}{2} A_1 + \frac{\sqrt{3}}{2} B_1 + A_3 + \tfrac{1}{2} A_5 - \frac{\sqrt{3}}{2} B_5 = e_1 \; . \; (b)$$

$$\frac{\sqrt{3}}{2} A_1 + \tfrac{1}{2} B_1 - B_3 - \frac{\sqrt{3}}{2} A_5 + \tfrac{1}{2} B_5 = e_2 \; . \; (c)$$

$$A_1 - A_3 + A_5 = e_3 \; . \; . \; . \; . \; . \quad (d)$$

$$\frac{\sqrt{3}}{2} A_1 - \tfrac{1}{2} B_1 + B_3 - \frac{\sqrt{3}}{2} A_5 - \tfrac{1}{2} B_5 = e_4 \; . \; (e)$$

$$\tfrac{1}{2} A_1 - \frac{\sqrt{3}}{2} B_1 + A_3 + \tfrac{1}{2} A_5 + \frac{\sqrt{3}}{2} B_5 = e_5 \; . \; (f)$$

* Based on a series of evening lectures delivered at the University College, Liverpool.

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We thus obtain six equations, and these enable us to determine the six unknown coefficients A_1, B_1, etc.

Adding (*b*) and (*f*), and (*c*) and (*e*), we get

$$A_1 + 2A_3 + A_5 = e_1 + e_5$$

$$\sqrt{3}\,A_1 - \sqrt{3}\,A_5 = e_2 + e_4$$

Also, by (*d*), $2A_1 - 2A_3 + 2A_5 = 2e_3$.

Adding the first and last of this set of equations, we obtain

$$3A_1 + 3A_5 = e_1 + e_5 + 2e_3,$$

which when divided by $\sqrt{3}$ and added to the second equation above gives

$$2\sqrt{3}\,A_1 = e_2 + e_4 + \frac{1}{\sqrt{3}}(e_1 + 2e_3 + e_5),$$

so that $A_1 = \frac{1}{6}\{e_1 + 2e_3 + e_5 + \sqrt{3}(e_2 + e_4)\}$.

From the other equations, we easily obtain

$$A_5 = \tfrac{1}{6}\{e_1 + 2e_3 + e_5 - \sqrt{3}(e_2 + e_4)\},$$

and $A_3 = \frac{1}{3}(e_1 - e_3 + e_5)$.

Next, subtracting (*f*) from (*b*), and (*e*) from (*c*), we get

$$\sqrt{3}\,B_1 - \sqrt{3}\,B_5 = e_1 - e_5,$$

$$B_1 - 2B_3 + B_5 = e_2 - e_4.$$

Using these two equations, along with (*a*), we find

$$B_1 = \tfrac{1}{6}\{e_2 - e_4 + \sqrt{3}(e_1 - e_5)\},$$

$$B_5 = \tfrac{1}{6}\{e_2 - e_4 - \sqrt{3}(e_1 - e_5)\},$$

$$B_3 = \tfrac{1}{3}(e_4 - e_2).$$

As an example, we shall take the periodic function represented in Fig. 32. Dividing the half-period into six equal parts, we find the following values of e:

$$e_1 = 9{\cdot}7\,;\ e_2 = 15{\cdot}06\,;\ e_3 = 9\,;\ e_4 = -2{\cdot}95\,;\ e_5 = -{\cdot}7.$$

Substituting these values in the expressions just obtained for A_1, B_1, etc., we find

$$A_1 = 8\,;\ A_3 = 0\,;\ A_5 = 1\,;\ B_1 = 6\,;\ B_3 = -6\,;\ B_5 = 0.$$

Hence the function is capable of being exhibited as the sum of the following simple harmonic terms:

$$8 \sin pt + 6 \cos pt - 6 \cos 3pt + \sin 5pt.$$

The first two terms, which represent two simple harmonic functions of the same period, may be combined into a single term (Art. 19), so that the given function may be written in the form

$$10 \sin (pt + \theta) - 6 \cos 3pt + \sin 5pt,$$

where $\tan \theta = \frac{3}{4}$. These three harmonic components are shown dotted in Fig. 32.*

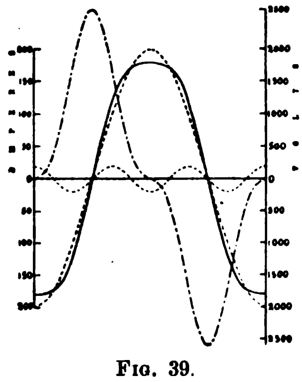

FIG. 39.

46. We shall next show how to apply the above method of harmonic analysis to the determination of the shape of the *current* curve when the E.M.F. curve is given. This method will be best understood by working out a numerical example.

In Fig. 39 let the chain-dotted curve be the given E.M.F. curve.* Dividing the half-period into six equal parts we find the following values of the E.M.F. corresponding to the first five points of division—

$$e_1 = 4{,}000\,;\ e_2 = 1{,}730\,;\ e_3 = 2{,}600\,;\ e_4 = 1{,}730\,;\ e_5 = 400.$$

Substituting these values in the expressions given above for A_1, B_1, etc., we find

$$A_1 = 2{,}000\,;\ B_1 = 0\,;\ A_3 = -600\,;\ B_3 = 0\,;\ A_5 = 0\,;\ B_5 = 0:$$

so that the E.M.F. is represented by

$$e = 2{,}000 \sin pt - 600 \sin 3pt.$$

Now the E.M.F.'s which act in any circuit are superposable—*i.e.*, each E.M.F. produces its own current just as if all the other E.M.F.'s were absent. The total resultant current in the circuit will be the algebraical sum of the currents due to the various E.M.F.'s in the circuit. Applying this principle to the case before us we may determine the currents corresponding to the simple harmonic components of the E.M.F., and then obtain the actual current by superposing these two.

We shall suppose, in the first place, that the circuit into which the alternating E.M.F. is introduced has negligible inductance, and that its resistance is 10. The impedance of the circuit will in this case be simply equal to its resistance, and the angle of lag will be nothing. Hence, the current in the circuit will be

$$200 \sin pt - 60 \sin 3pt,$$

and since the ratio of the amplitudes, and the phases, of the two simple harmonic components of the current are precisely the same as those of the E.M.F. components, it follows that the *shape* of the current curve will be precisely the same as that of the E.M.F. curve. The chain-dotted curve may, in fact, be taken to represent, to a different scale, the current. This result will obviously apply to any number of simple harmonic components, so that *when the inductance of a circuit is negligible, the current wave is of the same shape as the applied E.M.F. wave.*

We shall, in the second place, consider the other extreme case—that, namely, in which the *resistance* is negligibly small and the inductance considerable. Let the periodicity be 100 ~ per second (Art. 39), and let the inductance of the circuit be ·0159 henry (Art. 32). The impedance will now be simply equal to the reactance, and the angle of lag will be $\frac{\pi}{2}$—*i.e.*, a right angle (Art. 40). It must be remembered, however, that the reactance is a function of the periodicity. Hence, since $p = 2\pi n = 2\pi \times 100$, the reactance for the first harmonic term, $2{,}000 \sin pt$, is $pL = 200\pi \times {\cdot}0159 = 10$; and the reactance for the second harmonic term, $-600 \sin 3pt$, is $3pL = 30$. The *currents* corresponding to these two terms will therefore be

$$\frac{2{,}000}{10} \sin \left(pt - \frac{\pi}{2}\right) = 200 \sin \left(pt - \frac{\pi}{2}\right)$$

and

$$-\frac{600}{30} \sin \left(3pt - \frac{\pi}{2}\right) = -20 \sin \left(3pt - \frac{\pi}{2}\right)$$

respectively. These two harmonic currents are shown dotted in Fig. 39. The actual current in the circuit is obtained by superposing the two harmonic components, and is

$$200 \sin \left(pt - \frac{\pi}{2}\right) - 20 \sin \left(3pt - \frac{\pi}{2}\right).$$

This current is the full-line curve of Fig. 39, and the student cannot fail to be at once struck by the widely different shapes of the E.M.F. and current waves in this case: the one is a *peaked* wave, the other a *flat-topped* wave. Remarkable as this result may appear at first sight, it might have been predicted from purely physical considerations. For since the resistance of the circuit is negligible, we must at every instant have

$$\text{applied E.M.F.} = L\,i' \text{ (Art. 33)},$$

where i' denotes the rate of change of the current at the instant under consideration. It follows at once that if the applied E.M.F. has a very small value at any instant,

* It may be as well to point out that the curve of Fig. 32 is not the E.M.F. curve of any alternator; it has been chosen merely to illustrate the method of harmonic analysis given above. Some typical alternator E.M.F. curves are shown in Figs. 31, 33, and 39.

* See Fig. 37, which shows the component harmonics of this curve.

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the value of i' must be correspondingly small. Now, a reference to Fig. 39 shows that over a certain portion of the E.M.F. wave—viz., in the neighbourhood of its zero points — the instantaneous values of the E.M.F. are extremely small; hence the corresponding values of i' must also be very small. In other words, the current varies very slowly during that time, and therefore its graph will be almost parallel to the axis of time. This is precisely what the curves in Fig. 39 show: the flat portion of the current wave corresponds to the hollow portion of the E.M.F. wave, over which the values of the E.M.F. are very small.

Another point which it is worth while to refer to in this connection is the following: If we compare the ratios of the *amplitudes* of the two component harmonics corresponding to the E.M.F. and current waves respectively, we find that the second harmonic term is relatively much greater in the E.M.F. than in the current wave—*i.e.*, the E.M.F. wave departs more widely from a pure sine wave than does the current wave. Hence one of the effects of inductance is to *smooth down* the *current wave** so that it approximates more closely to a sine wave than does the E.M.F. wave.

47. Since we suppose the circuit to be one of constant permeability, the current wave in Fig. 39 will also represent to a different scale the wave of magnetic flux. We thus see that a *peaked* E.M.F. wave gives rise to a *flat-topped* wave of magnetic flux in a circuit whose reactance is great compared with its resistance. If the student will draw the current wave corresponding to a flat-topped E.M.F. wave, he will find that the former is peaked. We thus arrive at the following result:

In a circuit whose resistance is small compared with its reactance a peaked wave of impressed E.M.F. gives rise to a flat-topped wave of magnetic flux, and vice versâ.

This result will also hold for a circuit containing iron, since the E.M.F. induced in any circuit is always measured by the rate of change of the magnetic flux through the circuit, quite independently of the medium in which the flux may be produced. The difference between the two cases lies in the shape of the *current* wave, which in a circuit of constant permeability is similar in shape to the magnetic flux wave, but in a circuit containing iron differs considerably from it.

(*To be continued.*)

ON THE SEAT OF THE ELECTRODYNAMIC FORCE IN IRON-CLAD ARMATURES.†

BY EDWIN J. HOUSTON, PH.D., AND A. E. KENNELLY, SC.D.

In the smooth-core armature of a motor, say, of the drum type, it is known that the electrodynamic force, which urges the armature around, is exerted upon the conductors wound thereon, and not upon the armature core. In such armatures the wires are apt to be turned or sheared around the core by the action of unduly powerful currents.

Fig. 1 represents the cross-section of a drum armature with 12 wires laid over its surface, and with the flux paths diagrammatically indicated, when the field is excited and current is passing through the armature. If the wires were free to move, like a cage, around the core, they would exert the entire torque of the motor, and, if hysteresis were absent, the core would have no tendency to rotate. The rotary effort of hysteresis in the iron core would necessarily be only a small fractional part of the entire torque of the motor, so that practically all the electrodynamic force exerted is upon the active conductors. When no current passes through these conductors, the magnetic flux is uniformly distributed through the air-gap over the surface of the field poles and armature.

The effect of passing the working current through armature conductors is twofold: (1) it produces a M.M.F. across the main magnetic circuit, thereby crowding the magnetic flux at the pole corners, *a* and *d*, and thinning it out at *b* and *c*, as shown; (2) it produces a distortion of the flux around each conductor, and it is this distortion which is the origin of the electrodynamic force on the conductor.

In the toothed-core armature it is generally considered that the electrodynamic force is exerted almost entirely upon the iron core and not upon the conductors. In other words, the function of the working current passing through the armature is to magnetise the iron armature core, and the field-magnet poles attract, so to speak, the magnetised core.

Fig. 2 represents a toothed-core armature situated in an excited bipolar field, but with no current passing through

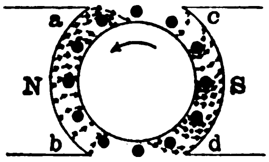

Fig. 1.—Bipolar Smooth-Core Drum Armature.

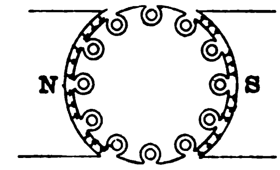

Fig. 2.—Bipolar Toothed-Core Drum Armature. Field Active and no Current in Armature.

the armature. Here the distribution of magnetic flux is uniform, as shown. Fig. 3 represents an active toothed-core armature in the same field. Here the flux is crowded together at the leading polar edge, as before, and thinned out at the following polar edge.

It is usual to consider that the iron core is magnetised by the current, so as to form, say, a north pole, *n*, beneath and a south pole, *s*, above, and that if the distribution of magnetic flux from a cylindrical magnet of this power were superposed upon the magnetic flux produced by the field, the resulting magnetic forces would have a torque identical with that of the electrodynamic forces indicated in Fig. 1. This view was, however, completely contradicted by the observations published in a paper by Prof. H. J. Ryan, on "A Method for Preventing Armature Reaction," read before the American Institute of Electrical Engineers in March, 1895 (*Transactions*, vol. xii., p. 84).

In carrying out his method of preventing armature reaction, Prof. Ryan applied an external M.M.F. on his

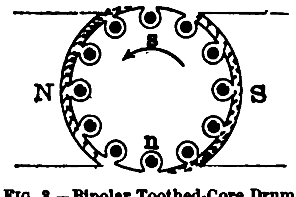

Fig. 3.—Bipolar Toothed-Core Drum with Armature Active.

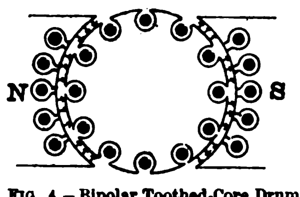

Fig. 4.—Bipolar Toothed-Core Drum Armature with Balancing Field Turns. Field and Armature Active.

toothed-core armature, equal and opposite to the internal M.M.F. developed in the armature conductors in the usual way. This was accomplished by cutting channels in the polar faces and embedding therein conductors which carried the armature current. By exploring the distribution of magnetic flux entering the armature, Prof. Ryan showed that when the balancing coils were left out of circuit the distribution was dissymmetrical, as indicated in Fig. 3, but that when the balancing coils were introduced with their opposing M.M.F., the resulting distribution of magnetic flux over the surface of the armature could be made practically uniform. In other words, the iron core of the armature was no longer magnetised as represented in Fig. 3; for the ampere-turns of the balancing coils, wound in the pole-faces, tended to produce a south pole where the ampere-turns on the armature tended to produce a north pole, and conversely. It was evident, assuming Prof. Ryan's observations to be correct, and they were too numerous to admit of experimental error in so fundamental a matter, that the armature core as a whole remained unmagnetised and yet the armature exerted its full torque. This is diagrammatically

* *Not*, be it noted, the induced E.M.F. wave (which in this case is equal and opposite in phase to the *peaked* applied E.M.F. wave). Failure to discriminate between the effects produced by inductance on the *current* and *induced E.M.F.* waves respectively has led to the remarkable fallacy, upheld by high authorities, regarding the "filtering" or "harmonic flywheel" effect of a transformer, or series of transformers, on an E.M.F. wave of irregular shape. It is only quite recently that Dr. Fleming has exploded this fallacy! Inductance *does* have a *smoothing* effect on the current wave, but *not* on the *induced E.M.F.* wave.

† From the *Electrical World* (New York).

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represented in Fig. 4, where the distribution of flux over the surface of poles and armature is indicated as uniform.

The question therefore naturally arises, Does the driving force in the case of the toothed-core armature, with balancing turns, revert to the active conductors when the armature core as a whole ceases to be magnetised?

In order to answer this question, the authors have designed a small experimental motor, in which the conductors are embedded in tunnels carried through near the surface of the drum armature core. A front view of this motor is represented in Fig. 5, where it is seen to be a small bipolar machine. Fig. 6 represents the armature removed from the field. The armature is a solid cylinder of soft iron bored with 12 quarter-inch holes. The armature core is supported in brass straps bridging the pole-pieces. The conductors, 12 in number, are mounted in a cage having hard rubber faces or ends, which are capable of revolving freely upon the core shaft, through a small angular range—that is to say, within the limits of each core tunnel. There is no commutator, and the current was carried into and out of the conducting cage by flexible copper wires. Under these circumstances the armature core was free to revolve, and the armature conductors were also free to revolve independently of the core, but within narrow angular limits only. Two small pulleys were employed, one mounted on the core shaft and the other on the conductor cage, so that the torque exerted independently by each could be observed. The armature was never allowed to run and was only permitted to develop a torque through a very limited angular range of position.

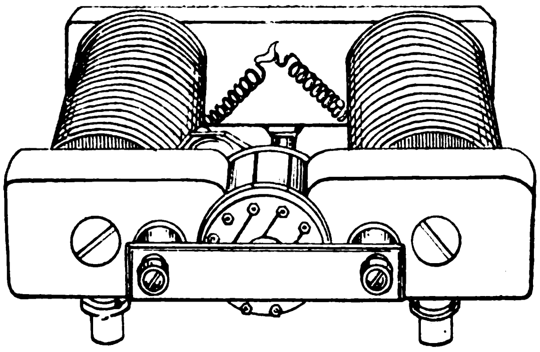

FIG. 5.—Front View of Experimental Motor.

The field magnets are of cast iron, and the pole-pieces are grooved with five parallel grooves for the reception of the balancing turns, as shown in Fig. 7. The field winding consisted of 648 turns of No. 19 B. & S. wire on each field spool. With a current strength of one ampere passing through the coils in series, representing a total field M.M.F. of 1,296 ampere-turns, or 1,629 gilberts, the magnetic flux passing through the armature was approximately 50,000 webers, and through the centre of the cast-iron yoke about 64,250 webers. The maximum intensity in the iron teeth of the armature was approximately 13·1 kilogausses.

It was found that the frictional torque of the armature core with the field unexcited was approximately 10·6 gm.-cm. The frictional torque increased when the field was excited to 42·4 gm.-cm., representing an hysteretic torque in the iron core of 31·8 gm.-cm.

When a current of 19 amperes, supplied by storage cells, was passed through the armature conductors, making five turns round the armature core, it was found that the magnetic torque on the iron core was 336·5 gm.-cm., and on the conductors only 5·4 gm.-cm.

Taking the total magnetic pull upon the armature core as 378·9 gm.-cm., the sum of the observed and frictional torques, the total magnetic torque on both core and conductors was 384·3 gm.-cm., of which 98·6 per cent. was exerted on the iron and only 1·4 per cent. on the conductors.

It was also found that the insertion of five turns of balancing coil wound in the polar faces did not perceptibly alter the torques developed at the core pulley and conductor cage pulley, indicating that the pull is still practically all exerted on the iron, whether the balancing conductors are employed or not.

In the same way, a small angular motion of the iron core induces in the conductors a transient E.M.F., while the same range and character of angular motion in the conductor cage produced a barely appreciable E.M.F., and this whether the balancing coils were employed or not.

The evidence derived from this experiment, together with the experiments detailed in Prof. Ryan's above-mentioned paper, indicate, that when balancing turns are employed, the iron core, as a whole, is not magnetised, but that the teeth are individually magnetised—that is to say, there is no dissymmetry of magnetic flux distribution over the surface of the armature core taken as a whole, but there is local dissymmetry of distribution on the surface of each tooth, whereby the flux is crowded at the leading edge and thinned out at the following edge of each tooth. By winding coils of insulated wire around the edges of the teeth, and connecting these coils with a ballistic galvanometer, we have observed that this action takes place, consequently the magnetic forces are locally exerted upon the teeth of the armature core.

If we accept this conclusion, it must follow that the distribution of magnetic flux in Fig. 4, although represented as uniform in so far that the same amount of flux enters each armature tooth as a whole, is not accurate in detail, since the flux passing into each tooth should be crowded at the advancing edge and thinned out at the following edge. Moreover, the same effects must be developed when no balancing turns are employed, as in Fig. 3, except that, in addition to the local dissymmetry at each tooth, there is an additional total dissymmetry over the surface of the entire armature.

The final conclusions appear therefore to be as follows: (1) The distribution of magnetic flux over the polar surface

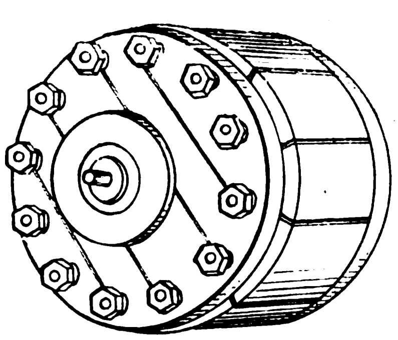

FIG. 6.—Armature of Experimental Motor.

of a toothed-core armature may be regarded as practically uniform when no current passes through the armature. (2) When the working current passes through the armature coils two effects are produced—viz.: (*a*) a local dissymmetry of magnetic flux in each tooth whereby the flux is crowded at the advancing edge and thinned out at the following edge; (*b*) the M.M.F. of the armature as a whole distorts the general distribution of the flux over its surface. (3) When balancing coils are employed, the main distortion just alluded to under (*b*) may be annulled, but the local dissymmetry (*a*) is only slightly modified and remains in full force.

Reflector for Street-Lighting. — Mr. W. H. Kincaid, of Santa Barbara, California, has invented a special arc lamp reflector for use at street crossings. The object of the lamp at a right angle crossing of two roads is, the inventor thinks, to light the roadways only. If, therefore, the light issuing from the lamp can be confined to the roadways by reflectors, an increased lighting effect should be obtained. He effects this by means of four vertical reflectors whose horizontal sections are parabolas. The arrangement of reflectors is shown in the current number of the New York *Electrical Engineer*. From the diagrammatic sketch we gather that the arc would never be visible from any point, but that the whole of the light is reflected by the mirrors. If the mirrors are accurately designed, the result would be to give four narrow beams of light. The width of the beam would also be much more narrow than the roadway. The strong local light thus obtained would be very objectionable from a driver's point of view, and we cannot see that the invention is likely to find favour.

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STATE-OWNED TELEGRAPHS.

The comparison between the telegraphic service in two countries so widely different in extent and in density of population as Great Britain and the United States of America is no easy task if justice is to be done to both sides. Again, if the question of the influence of State ownership is to be added to the comparison, any conclusions neglecting the difference between the constitution of the countries is valueless. We notice that Mr. W. J. Bryan, the democratic candidate for the presidentship of the United States, has included the State ownership of telegraphs and telephones in his programme. Certain of the technical papers have accordingly taken him to task, and at the same time have depreciated the telegraphic service of this country. The chief point found fault with is our annual deficit, which, for the year ending March, 1895, amounted to about four hundred and forty thousand pounds. The question for the technical papers is rather that of the cost of the service than the price fixed by the Parliamentary representatives of the people. The telegraphic system in America is practically in the hands of the two large companies called respectively the Western Union and the Postal Telegraph Companies. These two powerful companies compete in certain districts, but the rates are not subject to competition. As a result, the company showing the best despatch in its business gets most custom, and in certain cases an exceptionally good service is given in consequence. The annual expenditure of those companies averages about 70 per cent. of the the gross receipts. The remaining 30 per cent. is, of course, distributed in capital charges, interest, and direction expenses. In England, with Government control, for the year ending March, 1895, the expenditure exceeded the receipts by about 5¼ per cent., and after adding the capital charges, the deficit rose to about 17 per cent. of the receipts. Looking at the question as above, the favour of the business man turns to the paying concern. The other side of the question, however, needs careful consideration. What does the general public have to pay for its telegraphic facilities? In America the average cost of a telegraphic message is practically double that in England, while the cost of a press message of a given length is seven times dearer in America than here. We need hardly refer to the fact that a readjustment of the price for Press telegrams only would wipe out our present deficit. In fact, our press telegraph service is carried on at a loss, and there is little doubt but that the ordinary telegraph message is remunerative. The higher rates in America and the extended area to be covered has in that country practically kept the telegraph service out of reach of the average household. Thus the two competing companies devote their chief attention to cities where the large number of messages repays them for their outlay. The smaller towns suffer from the lack of competition, and in the average village the telegraph is seldom installed. As a consequence business communications receive prompt attention, but any service other than a main route suffers. In

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England, under the control of the Government, a good service is maintained everywhere. The small and often non-paying stations receive adequate attention, so that the time taken in sending a message to any place is not dependent on the importance of that place. The whole telegraphic system is considered rather as a public convenience than as a money making concern. One other point needs attention in reference to the annual deficit shown in the account. On examination it will be seen that the capital charges do not increase. In other words, all extensions are charged not to the capital account, as is the custom in commercial businesses. Thus the extensions, of which an enormous number have been carried out since 1870, have been charged to the annual expenses. This is hard on the annual balance-sheet, comparing revenue with total expenditure, and must be borne in mind when talking of the deficit. It is absurd to suppose that the capital value of our telegraph equipment has stood still for the last twenty-five years. We conclude that the average English service is both better and much more cheap than the average service in America, and that this is due in no small measure to State control. The difference in the density of the population tends to explain the greater cost of the American service. The question as to whether State control would cheapen and improve their service is dependent on the organisation of the control. We think it would not if the department is to be run on political lines, with a chaotic period at every presidential election due to changing all the chief officials.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

LIGHT LOCOMOTIVES.

Sir,—After a long period of labour, the "Locomotive on Highways Bill, 1896," has become an Act, and probably at no period in the history of the English Legislature has so liberal a measure been passed; indeed, the President of the Local Government Board cannot be charged with a want of faith in humanity, believing, as he must do, that no abuses will follow the help he has so freely extended to the new movement.

For the great freedom given in this measure I feel that I am in a large degree responsible, Mr. Chaplin and the officials connected with the Local Government Board and the Home Office having accepted the various points which I advocated in person and in writing, as well as the amendments which were finally adopted in committee on Mr. Chaplin's recommendation, and those which were not opposed by him at that committee.

In rendering all the assistance in my power to those who had charge of the Bill during its passage through the Houses of Parliament, and to those whose duty it now is to make regulations in connection with this Act, my hands were immensely strengthened by the support received from so many distinguished and eminent men conversant with the subject—all, like myself, entirely disinterested and unbiassed by personal or pecuniary motives. These gentlemen include statesmen, engineers, scientists, and a host of others.

My object in requesting the publication of this letter is, on the one hand, to express the gratitude of all those I represent in this movement to the Government, to the permanent officials of the departments concerned, and to all others by whose labours and influence success has been obtained; and, on the other, to appeal to everyone interested in the movement, whether as manufacturers or users of motors, to do nothing on their part to abuse the freedom which has now been extended to them. It behoves everyone concerned to act with prudence and consideration; to avoid injury to the roads; to use every possible care not to frighten horses; to store no dangerous liquids thoughtlessly, which might endanger life or property; and to act generally with such discretion that it shall not be said in a year or two hence, another Act must be passed to control those who have shown their inability to control themselves or have misused their privileges.

There cannot be the slightest doubt in the mind of any reasonable man that this Act will be productive of great changes, and that if all those who have an interest in modern progress will strive to improve self-propelled traffic, and those who avail themselves of its benefits will act fairly towards others having no direct interest in the movement, it will be giving the English nation an advantage which can hardly be overrated and without entailing, as I hope and believe, a vestige of discomfort or annoyance on any individual.—Yours, etc.,

David Salomons,
President, Self-Propelled Traffic Association.
Offices of the Association, 30, Moorgate-street,
London, E.C., August 15, 1896.

THE PLYMOUTH REPORT.

Sir,—I have read with much interest the report of Mr. J. H. Rider to the Electric Lighting Committee of the Plymouth Corporation on the question of the electric supply for lighting and traction purposes. It would be very interesting to many, and particularly so to myself, if Mr. Rider would publish the detailed figures showing how he arrives at the cost of electric traction at 6d. per car mile, with current alone costing 3½d. per car mile.

I enclose my card, and subscribe myself as

One Seeking after Knowledge.

THE NEW ZEALAND GOVERNMENT CABLE SHIP "TUTANEKAI."

The above-named vessel, which was built for the Government by Messrs. Dunlop and Co., of Port Glasgow, is designed for several purposes, the most important of which is the repairing of the New Zealand Government cables. Messrs. Johnson and Phillips, of Charlton, who make a speciality of cable laying and repairing machinery, were entrusted with the complete outfit of apparatus, accessories, and stores for this purpose. One novelty in the design of all the deck, cable machinery, and fittings supplied for this vessel, is that it can all be easily removed, so that when the ship is not required for cable purposes the whole of it can be taken away and put into store, leaving the decks free. All the holding-down boltholes are provided with sockets, into which plugs can be screwed so as to leave the deck perfectly watertight when the gear is removed. The picking-up and paying-out machine, illustrated herewith, is extremely compact, though it is a double machine. It is designed to pick up cables under a strain of 20 tons. It only weighs 9¼ tons, and only occupies a deck space of 8ft. 3in. by 11ft. 6in. It is very similar in design to the gear recently fitted by Messrs. Johnson and Phillips on the Japanese Government steamer, except that it is not quite so powerful and has horizontal engines instead of vertical. The machine is built on two frames made of steel plates, with steel angles inside and outside with welded corners. The drum shaft, which has large collars welded on for attachment to the frame, ties them well at the top. The forward bottom ends are tied by a steel plate and also by a flange shaft, which carries the fleeting knives, and takes the eyes of the main brake straps. There is also a "T" stay bar at the bottom after-end, as well as diagonal stays at each end of the pairs frames. This makes a very stiff job, and allows of the

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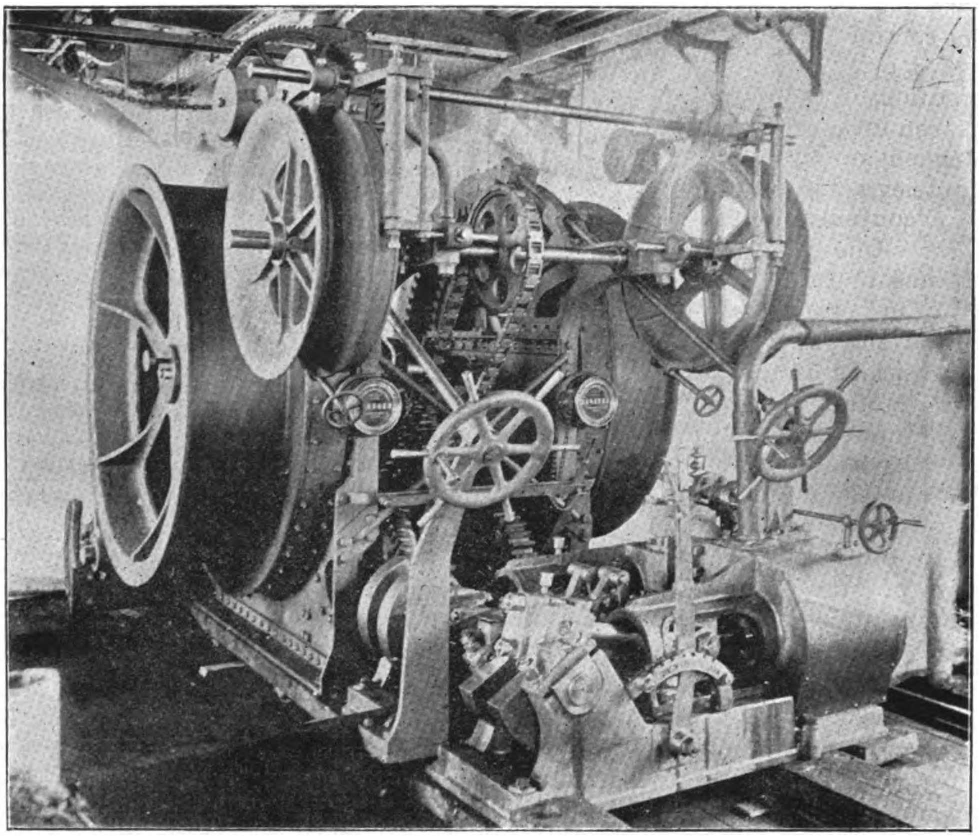
whole of this part of the gear being lifted out in one piece without fear of the shafts or bearings getting out of line. The machine is designed for two speeds, which can be geared on to either drum, but the port drum only is intended for the heavy lift of 20 tons. It is accordingly built of steel, whereas the starboard drum is of cast iron. These drums are 6ft. 7in. diameter by 2ft. wide over all. They are internally geared, and have a rim cast on for the main brake; hence they combine the main drum, brake drum, and gear wheel in one. These drums are arranged to run loose on the shaft, and are capable of different combinations with the gearing as follows: Both drums can work loose without the engine; both drums can work at the same speed with the engine; one drum can be driven by the engine while the other runs independently; one drum can be held by the brake while the other is being worked by the engine; power of both brakes can be put on to one drum by keeping the pinions in gear. All wheels are arranged to draw out of gear where possible when not required for driving, so as to avoid rattling. In the case of the pinion which gears with the large drums, this necessitated cutting large holes in the frame, so that the pinion could pass right through them. The frames at these parts are provided with large circular cast-iron pockets which carry bearings at each end, so that when the pinion is in work it is close up to a bearing, thus ensuring a very sound job. The brakes consist of steel straps with elm blocks attached, the ends of the straps being fitted with steel castings which carry nuts with right and left hand threads to take the brake screws. The screws and rods are taken down to the after end of the machine, so as to be worked from the main deck. The lower part of the brake strap is fitted with a large cast-iron eye, which transmits the strain to the lower part of the machine frames by means of a steel shaft, which is secured to the frames by large cast-iron flanges.



The Johnson and Phillips Picking Up and Paying Out Gear Fitted to ss. "Tutanekai."

Hauling-off gear is driven by chain from the intermediate shaft, so that its speed is always proportionate to that of the drums. For holding-back purposes the sheaves have a brake rim cast on them, and on these rims a steel strap with screw adjustment is fitted so that the amount of "drag" put on the cable can be adjusted minutely. The sheaves can slide along on their shaft to suit an inside or outside lead. A small Worthington pump is fixed between the frames to supply the main and holding-back gear brakes.

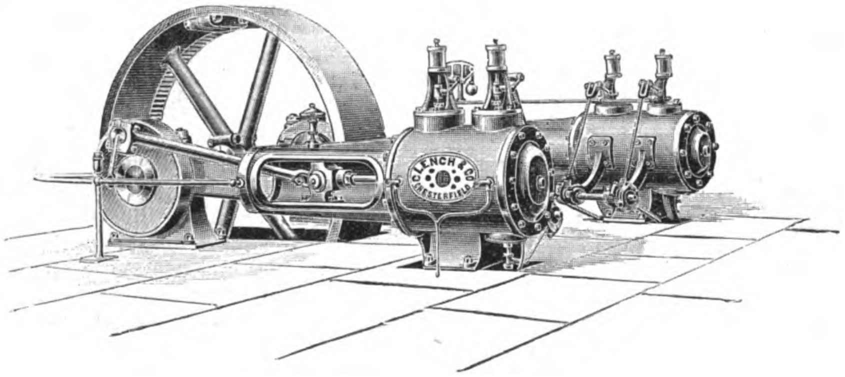


FIG. 1.—General View of the Clench Horizontal Engine.

The engine has cylinders 9in. and 16in. by 10in. stroke suitable for steam 160lb. per square inch, and it is complete with automatic bye-pass valve, steam valve, and link motion reversing gear, all of which, with the main and holding-back brakes, are within reach of one man at the after end of the machine. The gear was run under steam pressure at Messrs. Johnson and Phillips's works, and also on board the vessel to the satisfaction of the consulting engineers, W. H. Preece, Esq., and W. R. Culley, Esq., of

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H.M.T.S. "Alert." The bow gear consisted of two steel sheaves, 3ft. 2½in. diameter by 11½in. wide, which run loose on a steel shaft supported in cast-iron brackets attached to three steel girders. Each sheave is provided with cast-iron whisker guards to prevent the cable getting off the sheave, these guards also being bolted securely to the whiskers. The girders are fitted with eyes and bollards to secure the stoppers. A davit is provided between the sheaves for launching mushrooms, etc., and is arranged to fold down out of the way when necessary to let go the "bight."

The vessel is fitted with the usual dynamometers, lead wheels, deck leads, troughing, etc., and is fully equipped with a complete outfit of stores and accessories, including grapnel and buoy ropes, grapnels, mushrooms, buoys, chains, sounding shot, steam sounding machine, steam hauling gear, etc., and the testing room is provided with a set of first-class instruments.

THE CLENCH HORIZONTAL ENGINE.

We are indebted to Messrs. Clench and Co., of Lincoln Works, Chesterfield, for the following particulars of their new type of horizontal engines which has been designed for electric lighting purposes. Fig. 1 shows a general view of the engine, which is of the cross-compound type, with the high-pressure cylinder on the right-hand side when standing at the cylinder end.

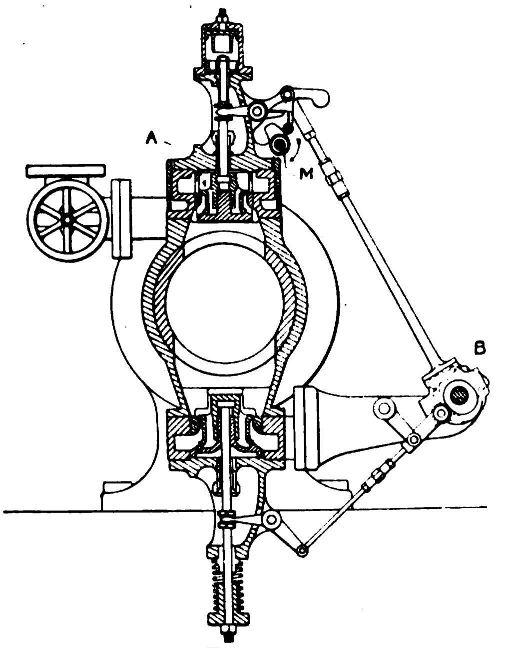

Fig. 2.

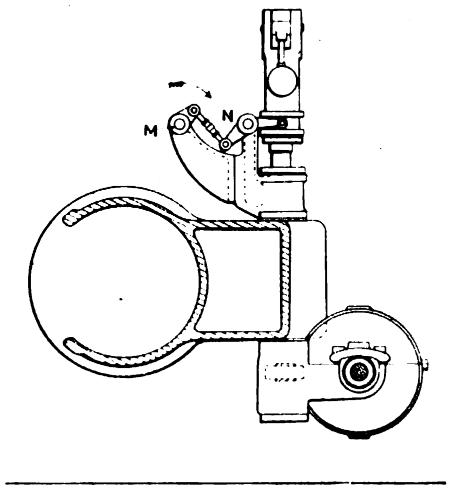

Fig. 3.

Each cylinder is jacketed with high-pressure steam, as is also the intermediate receiver. A by-pass valve is arranged to admit steam directly from the high-pressure supply into the low-pressure cylinder, so that the engine can be started in any position. The valve gear is the special feature of this engine. It is of the Clench patent trip-gear type. A good idea of the construction of the gear can be obtained from Figs. 2, 3, and 4. This valve gear, by reason of its simplicity, overcomes the chief objection to the use of the double-beat equilibrium valve for the distribution of steam in the cylinder of an engine. At the same time it secures practically a constant lead, instantaneous cut-off, and freedom of action for the governor, in a degree the makers claim has been never before obtained by the usual and more complicated arrangements. Figs. 2 and 3 show the side elevations and sections of the engine and cylinder with the valves and gear.

Fig. 4 is an enlarged view of the lifting levers showing the trip arrangement. The valves, A A, are raised each by an eccentric, B or C, on the lay shaft, D, which is driven by skew gears from and revolves with the engine shaft. The eccentric is connected through a fork to a pair of loose links, F, between which lie the lifting levers. Engagement is made with the lifting lever by the hanging link, H. The bottom end of link H is prolonged and carries a roller, J, which as the link descends comes in contact with the cam, K, which releases the lifting lever and allows the spring, L,

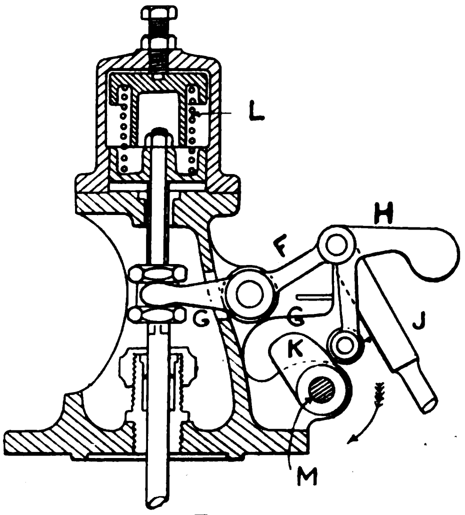

Fig. 4.

to close the valve. The valve is prevented from closing with too great force by an air cylinder and clack. The automatic closing of valve is effected as follows: The spindle, M, carrying the cam, K, is connected by the links, N, as shown, to the governor. The governor in rising turns the spindle with the cams in the direction indicated by the arrow, causing the roller, J, to come in contact with the cam, K, and so releases the valve at an earlier period of the stroke. Thus the governor regulates the position of the cam to give an earlier or later cut-off according to its position, which is according to the speed of the engine. The exhaust-valves are, like the above, of the double-beat equilibrium type, and are operated by cams on the lay-shaft as shown.

ALTERNATE-CURRENT TRANSFORMERS.*

BY DR. J. A. FLEMING, F.R.S.

LECTURE IV.

The Employment of Transformers.

In this last lecture I wish to direct your attention to certain problems in connection with the employment of transformers. I shall assume that the majority present are quite familiar with the ordinary methods of distributing electric current by means of transformers, whether by what is called the system of distri-

* Cantor lectures delivered before the Society of Arts.

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bution by house transformers, as shown in Fig. 47, or the more modern and economical method by transformer sub-stations. Generally speaking, the method of transformer distribution which is now found to be most practically useful in provincial towns and over large areas is somewhat as follows: In the generating station, the alternators either send their current into one common set of omnibus bars, the alternators working in parallel, from which bars a distribution is made by high-tension feeders to various transformer sub-stations; often a more complicated switchboard is employed in which the high-tension feeders coming from the various transformer sub-stations can be connected at pleasure to any alternator, or grouped together in any way on one or more of the alternators. It would be foreign to our subject here at the present moment to enter at all into the question of the parallel-working alternators. It has been fully discussed in the technical journals and other publications. The high-tension feeders are generally arranged to convey a high-tension current at a pressure of 2,000 volts to certain transformer sub-stations in which are placed a bank of transformers. These transformers take their primary current through primary switches and fuses from primary omnibus bars connected to the feeders, and the secondary circuits of the transformers are generally arranged to feed a three-wire system of low-tension distribution. For this purpose each transformer is provided with three secondary terminals, and from the sub-station proceeds a three-wire low-tension system which is fed by one or more of the transformers, and to which the consumers are connected. In joining up a bank of transformers in this manner it is important that each of the transformers should have an equal percentage secondary drop for the same fraction of full load. Otherwise, if one transformer has a smaller secondary drop than another that transformer with the least secondary drop will take the greatest share of the load as the sub-station is loaded up, and it may, therefore, get overloaded and get very hot, and such an inequality of load tends to increase the more the bank of transformers is loaded up. It is always advisable to examine transformers in this manner, and if any transformer is found to have too large a secondary drop then to remedy it by adding one or more turns to the secondary circuit. In addition to a low-tension distribution from transformer sub-stations it is sometimes found convenient to run one or more high-tension feeders to supply the outlying regions of the district which is then served with a system of house transformers. The plan which I have found convenient to adopt in developing an alternating-current station in a provincial town in which there is a central shop district, in which the lighting is rather dense, and an outlying residential district in which it is rather scattered, is to arrange one or more low-pressure secondary networks on the three-wire system in the central portion of the town. Each of these networks is fed from a single transformer sub-station, and the secondary circuit forms a complete ring main, which is fed into by secondary feeders at three or four places. The transformer sub-stations are inter-connected by a high-pressure connecting main, which serves, in case of breakdown at one station, to allow the duty of that station to be taken up by another sub-station. It is not advisable, in my opinion, to connect together the different separate secondary networks. One great advantage of the alternating-current system is that it enables us, by having small separate secondary distribution systems perfectly insulated from one another, to limit the effect of a dead earth on one of these secondary networks, and that is an advantage which cannot be obtained on the ordinary low-pressure system, where the distribution network is connected throughout.

As regards the description of cable to be employed, it is now well understood that concentric cable forms in all cases the most satisfactory of cable both for the high-pressure and the low-pressure conductors. By the employment of concentric cable, we eliminate at once any difficulties which would arise due to induction taking place on neighbouring telegraph and telephone wires; and we also largely reduce the inductive drop in pressure which would otherwise exist if the three members of the secondary circuit were separate cables separated by any distance from one another. My own experience is that the secondary network is best laid down by means of triple concentric cable, and there are certain advantages in making the outer member of this cable the middle wire of the three-conductor system. In any case, the house connections are quite easily made. It is also desirable to get rid altogether of distribution boxes and service boxes, which become localities in which coal gas can collect and occasionally explode. In laying down the secondary distribution system by means of lead-covered and armoured triple concentric cable, by far the best plan is to make the proper connection with a service main to each house at the time that the cable is laid, and to have this joint entirely sealed up in lead, making use of no junction-box, or at most of a right-angle iron sleeve to mechanically protect the joint. The service main can then be taken into each shop or house, and connected up to the consumer's terminals, whether the building takes light or not. In the central portions of a town it is only a question of time for every shop or house to take the current, and it saves expense ultimately to make this joint in the first instance. The secondary cable having been laid in this manner should be tested, and my own practice is to insist upon a test of 1,000 volts between the different members of the secondary circuit when it is laid in the earth, but before the house connections are made. If the cable stands this test, it has a large factor of safety. With regard to the high-pressure cable it is customary to use ordinary duplex concentric cable, and if the service is a 2,000-volt service, then after the cable has been laid in the ground it should be tested by a pressure of 4,000 volts placed between the inner and outer members for one hour, and a pressure of 2,000 volts between the outer member and the earth, and the cable should not be accepted unless it has passed this test. As it is always desirable to use concentric cables in connection with all modern transformer systems of distribution it is necessary to pay attention to some peculiar effects which are observed in connection with concentric cables when supplying transformers, and during the remainder of the lecture I propose to occupy your attention chiefly with practical points connected with these effects. They may be divided into four classes. There are first those which may be called the resistance effects, which are effects connected with the distribution of the current over the cross-section of the conductor employed for the transmission of the alternating current. Secondly, there are the capacity effects, which depend upon the fact that a concentric cable is a large condenser or Leyden jar. Thirdly, there are the resonance effects, which are due to the reaction of this capacity upon the alternators or the primary transformers. Fourthly, there are effects which may be called the initial stage effects depending upon the capacity of the cable and the inductance of the transformers supplied through it, both of which co-operate together to produce peculiar effects at the moment when the cable carrying the transformers is switched into connection either with another live cable or with an alternator. We shall consider each of these in turn. It will be necessary to preface a detailed discussion of these effects by some general remarks upon the nature of current flow in inductive circuits. Every electric circuit which has self-induction or inductance and capacity has a natural period of electric vibration—that is to say, if the electric charge in it is disturbed and then left to itself, it oscillates backwards and forwards as water would do in a long tube having the ends closed by elastic caps. In such a case, if the water was disturbed and then left to itself, it would oscillate to and fro in virtue of the fact that the mass of water possesses inertia, and that the elastic caps on the ends of the pipe permit the water to be displaced. In other words, such a closed pipe has what may be called hydraulic inertia and permittance. In the same manner a circuit which has self-induction possesses what may be called electric inertia or inductance, and a condenser which permits of electric displacement to be made through its dielectric or non-conductor has what is called capacity or permittance. If a condenser with a capacity, C, is being charged through a resistance, having a value represented by R, the product, C R, is called the time-constant of that system, and it represents the time in which the charged condenser, if left to itself, short-circuited by the resistance, R, would fall in potential, to a certain fraction (very nearly two-thirds of its original potential); again, if L is the inductance of a conductor and R is its resistance, then $\frac{L}{R}$ is called the time-constant of that circuit, and this is the time in which a current in that circuit would rise to about two-thirds of its full value if a constant E.M.F. is put upon the ends of the inductive resistance. The first product, C R, is called the electrostatic time-constant of the condenser and resistance, and the quotient, $\frac{L}{R}$, is called the electromagnetic time-constant of the inductive resistance. If, then, we join together in series a condenser having a capacity or permittance, C, and an inductive resistance having an inductance, L, and a resistance, R, it can be shown that the complete, free, periodic time of oscillation of a charge of electricity in that system is given by this expression:

$$t = 2\pi\sqrt{\frac{L}{R}\,C R}.$$

In other words, the complete periodic time is equal to 2π times the geometric mean of the electrostatic and electromagnetic time-constants. It must be noted that this is the time of oscillation of the charge when left to itself, but it is, of course, perfectly possible to make what is called a forced oscillation, and that is what is done in every transformer system. These electrical quantities have their mechanical analogues. Suppose, for instance, we take a pliable lath with a weight on it, and fix it at one end, the pliability of the lath is the analogue of the capacity of the electrical system, the mass of the weight on the end is the mechanical analogue of the inductance of the system. If, then, we displace the lath or bend it, and leave it to itself, it vibrates to and fro with a natural period of its own, in virtue of the

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fact that the system has pliability or permittance, and mass or inductance. If the mass be small and the pliability is small the time of vibration is small, but if the pliability is great and the mass is great, then the time of vibration is great. Such a loaded flexible rod not only has a free period of vibration of its own if fixed at one end and set in oscillation, but we may give it a forced oscillation. Before explaining the manner in which certain electrical effects may be mechanically imitated by such a loaded lath, we will consider a little more in detail the properties of concentric cables when used with alternating currents. In the first place, a cable intended for use with an alternating current must not have the metal or conductor of which it is made of a thickness exceeding a certain value, for the reason that a certain time has to elapse before the current is established in the central portions of the conductor, and therefore if the conductor is used with alternating currents, its actual resistance depends upon the frequency and the thickness of the conductor. Without going into more elaborate explanations on this point, for which I refer the reader to other text-books, I may give here a table showing the resistance of high conductivity round copper conductors to continuous and alternating currents of a certain frequency, the results of which are set out graphically in a curve in Fig. 48.

The following table shows us that practically the largest conductor which should be used in connection with alternating-current work is a cable having an outside diameter equal to a $^{19}/_{12}$ cable, and that if the cable has a greater diameter then its resistance to alternating currents of a frequency 100 is sensibly different from its resistance to continuous currents. In the next place, with regard to capacity, suppose that a concentric cable is formed by putting one cylindrical tube in the interior of another cylindrical tube, the space between the tubes being occupied by a non-conducting material or dielectric having a specific inductive capacity equal to K, then if R_0 is the radius of the inside of the outside tube, and R_1 is equal to the radius of the outside of the inner tube, and if L is the length of the tubes, the capacity of this concentric cable in microfarads is given by this expression:

$$C = \frac{K\,L}{2\,(\log R_0 - \log R_1)\,2{\cdot}303 \times 9 \times 10^5}.$$

Then as regards the value of K for paper insulation, such as is used in the Ferranti cables, K has a value very nearly equal to 3; but if indiarubber is used, then K has a value very nearly equal to 4. On calculating out these values for most ordinary cables used for the conveyance of high-tension alternating currents, it will be found that for such insulating materials as paper Fowler-Waring composition, or various resinous substances, the capacity of the cable is generally about one-third of a microfarad per mile.

TABLE OF RESISTANCE OF HIGH-CONDUCTIVITY ROUND COPPER CONDUCTORS.

Cable strands and size.	Total cross-section area in sq. inches.	Resistance in ohms per 1,000 yards: For continuous currents.	Resistance in ohms per 1,000 yards: For alternating currents. Frequency 100 ⁀‿ per second.
$^{7}/_{18}$	·0126	1·974	1 974
$^{7}/_{17}$	·0172	1·452	1·452
$^{7}/_{16}$	·0225	1 108	1·108
$^{7}/_{15}$	·0285	·878	·878
$^{7}/_{14}$	·0351	·712	·712
$^{19}/_{18}$	·0351	·712	·711
$^{19}/_{17}$	·0477	·524	·524
$^{19}/_{16}$	·0624	·401	·401
$^{19}/_{15}$	·0789	·318	·318
$^{19}/_{14}$	·0973	·257	·257
$^{19}/_{13}$	·1289	·194	·195
$^{19}/_{12}$	·1645	·153	·155
$^{19}/_{11}$	·2048	·122	·1247
$^{19}/_{10}$	·2500	·100	·1034
$^{37}/_{16}$	·1227	·204	·2041
$^{37}/_{15}$	·1551	·162	·164
$^{37}/_{14}$	·1913	·131	·1334
$^{37}/_{13}$	·2534	·099	·1224
$^{37}/-$	·3000	083	·087
$^{37}/_{12}$	·3235	·077	·081
$^{37}/_{11}$	·4000	·063	·068
$^{37}/_{10}$	·4905	·051	·057
$^{61}/_{15}$	·2582	·097	·1004
$^{61}/_{14}$	·3185	078	·082
$^{61}/_{13}$	·4218	·060	·065
$^{61}/-$	·5000	·050	·056
$^{61}/_{12}$	·5385	·046	·052
$^{61}/-$	·6000	·041	·048
$^{61}/_{11}$	·6476	·039	·0465
$^{61}/-$	·7000	·0357	·0435
$^{61}/_{10}$	·8167	·0305	·0391
$^{91}/_{13}$	6354	0385	·0458
$^{91}/-$	·7500	·0330	·0412
$^{91}/_{12}$	·8111	·0305	0391
$^{91}/-$	·9000	·0277	·0370
$^{91}/_{11}$	1 0000	·0250	·0350

From what has been said above with regard to the resistance effect it must be noted that in the construction of a concentric cable the maximum thickness of the copper conductor cannot be more than about ½in. In cases where larger currents have to be conveyed than can be carried through the equivalent of a $^{19}/_{12}$ cable it is desirable to employ two concentric cables in parallel. Let us consider, then, the capacity effect. If a long concentric cable is connected to an alternator, the far end of the concentric cable being insulated, it is found that an electric current flows into and out of the cable, which may be sufficient to light one or more incandescent lamps. This is called the capacity current of the cable, and it is a current flowing across the dielectric or non-conductor from one copper member to the other. If C is the capacity of the cable measured in microfarads, V, the difference of potential between the two copper members measured in volts, and if p represents $2\pi n$, where n is the frequency, then the capacity current, I, is given by this expression:

$$I = \frac{C\,p\,V}{10^6}.$$

Thus, for example, supposing a cable, having a capacity current one-third of a mile capacity, has a potential difference of 2,000

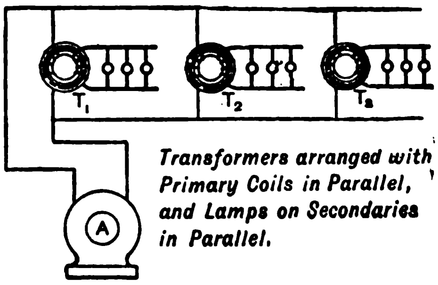

FIG 47.

volts between its inner and outer conductors, and p equals 500, then the capacity current is one-third of an ampere, or equivalent to the lighting current of one 8-c.p. lamp. Hence, in very large concentric systems, this capacity current going out of the station may amount to a considerable value. We have then to consider briefly what are called the resonance effects. If an alternator is separately excited so as to give a certain potential difference at its terminals, suppose 2,000 volts, and if a long length of concentric cable is connected to this alternator, the far end of the cable being insulated, then it will be found that such cable, when associated with the alternator, may greatly increase the electric pressure between the terminals of the alternator, and that for a certain critical length of the cable a very marked rise in pressure may take place. The same will be found to be the case if a long length of concentric cable is connected to the high-pressure side of a step-up transformer being excited from a 100-volt alternating circuit on the low-

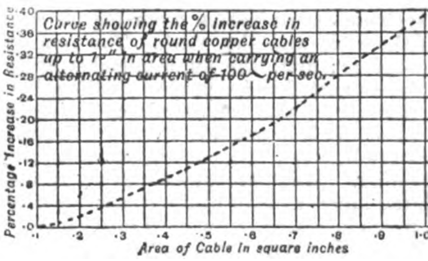

FIG. 48.

pressure side. Accordingly, in testing concentric cables, the engineer must always be on his guard against this resonance effect. Suppose, for instance, it is desired to test whether a certain length of concentric cable will stand 2,000 volts, the most natural method of doing this would be to connect the high-pressure side of a step-up transformer, raising the volts from 100 to 2,000, and to serve the low-pressure side of this transformer from a 100-volt circuit. The inexperienced person might naturally suppose that this would invariably place upon the cable a pressure of 2,000 volts, but under certain conditions, depending upon the capacity of the cable and the inductance of the transformer, the pressure might rise far beyond 2,000 volts between the two members of the cable, and the only method of making sure that this is not the case is to have an electrostatic voltmeter kept connected between the inner and outer members of the cable as the pressure is gradually increased.* Then, in the last place,

* For a further discussion of these resonance effects the reader is referred to "The Alternate-Current Transformer," Fleming, vol. ii., p. 383, *et seq.*, where a full discussion of these effects in connection with concentric cables is given.

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not only are there the resonance effects above referred to, by which a concentric cable when switched on to an alternator or transformer permanently raises the pressure, unless the exciting current of the alternator is reduced, but there are certain very important initial effects which take place at the moment when a concentric cable is switched into connection with either an alternator or another live cable. If a condenser is connected with an inductive resistance, it can be shown that at the moment when this system is brought into connection with the source of alternating E.M.F., if the connection is made at a particular instant with respect to the phase of the E.M.F., there is an electrical oscillation set up in the combined condenser and inductive resistance, the amplitude of the oscillations of current greatly exceeding those which would exist when the steady state has been established, and oscillations of potential difference occur at the same time, the result of which is that the difference of potential between the two plates of the condenser will undergo a periodic change, the amplitude of the oscillations of which is, however, in the initial stage much greater than that of those which take place when the whole system has settled down into a steady condition under the influence of the impressed periodic E.M.F.

Suppose, then, that a series of transformers are connected to the two copper members of a concentric cable, and that the concentric cable is, as usual, lead covered and steel armoured with a layer of insulation between the lead covering and the outer copper members. As already stated, there is a certain capacity in the concentric cable between the inner and the outer members, which will be generally something like one-third of a microfarad a mile, but, at the same time, there will be a capacity between the outer member of the concentric cable and the lead casing or the earth, and this capacity between outer and the earth, as it is called, is very much larger in general than the capacity between the innner and outer; it may be 10 times as great. Hence, if the transformers are connected between the inner and outer conductors, we may regard the primary circuits of the transformers, which are inductive circuits, as connected in series with a condenser, which is formed of the outer members of the cable and the lead covering. If, therefore, such a cable, with transformers attached to it, the secondary circuits of which are unloaded, is switched into connection with the omnibus bars of an alternating-current station, the connection between the inner member of the cable with the proper omnibus bar being made first, then, at that instant, an E.M.F. is impressed upon the system, consisting of the inductive primary circuits and the condenser in series with them. For a particular phase of the impressed E.M.F. it can be shown that oscillations of potential are set up in the condenser, causing a periodic potential difference between its two sides to be greater than that due to the steady action of the periodic E.M.F. This sometimes results in breaking down the insulation between the outer members of the concentric cable, and the lead covering, and as this insulation is generally in all cases made much thinner than that between the inner and outer members of the cable it is not unfrequently pierced. Alternating-current station engineers are very familiar with failures of such concentric cables occurring between the outer members of the cable and the earth. The remedy for this is one of two things: first, the outer member of the concentric cable must be connected to its proper omnibus bar first before the inner member of that concentric cable is connected. If this is done, then it is impossible to set up destructive oscillations of pressure between the outer members of the cable and the lead covering. Another remedy is to introduce in the circuit with the inner member of the concentric cable a variable inductance which is gradually removed in such fashion that the inner member of the concentric cable is not connected suddenly with the source of potential, but is connected through a choking coil, the choking quality of which is gradually removed. This can be done in the following manner: a large transformer is arranged so that its secondary circuit can be gradually short-circuited by lowering two lead or iron plates into an insulated tub of water; the primary circuit of this transformer can be connected in series with the inner member of the concentric cable which is to be brought into connection with the system. The operation, then, of connecting the long concentric cable to the omnibus bars is as follows: The series transformer first has its secondary circuit opened; its primary coil is then connected in series with the inner members of the concentric cable to be connected, and with the proper omnibus bar; the outer member of the concentric cable is then connected with the other omnibus bar; the plates on the secondary circuit of the series transformer are then gradually lowered into the water, and when the secondary circuit of this series transformer is practically short-circuited the primary circuit of the transformer is also short-circuited, and the transformer is then removed, leaving the main in connection with the omnibus bars. The operation, moreover, is performed in such a manner that there is no rush of current into the cable, and no possibility of setting up violent oscillations of potential between the outer members of the concentric cable and the earth. In no case should long concentric bars be connected to omnibus bars or to other parts of an alternating-current system without some such process as the above of gradually setting up the full current in them, or else the risk of piercing the outer insulation of the concentric cable is very considerable. Engineers in connection with alternating-current stations should always be on their guard against these initial effects, and remember that long concentric cables, with transformers connected to them, possess a quality which resembles inertia, and that currents can no more be started and stopped instantly in these cables and transformers than heavy machinery can be started and stopped at once.

In addition to the initial effects taking place in cables, I showed, in 1892, that there were certain initial effects, called current rushes, taking place in transformers when suddenly switched into connection with a live cable. Under some circumstances, depending upon the phase of the E.M.F. in which the switch is closed, a strong rush of current may take place into the primary circuit of a transformer, the maximum value of that current rising to twice the maximum value of the current when the steady state is established; and, under some conditions, in switching off a transformer, there may be a certain rise in the difference of potential between the parts of the primary circuit and the iron case or secondary circuit which may pierce the insulation. If a large current is flowing in an inductive circuit, and a switch is suddenly opened, interrupting that circuit at an instant when the current has its maximum value, then a large inductive E.M.F. is set up in that circuit which may result in breaking down the insulation between parts of that circuit. The effect arises from the same cause that frequently destroys the insulation of a field magnet of a continuous-current motor or dynamo if the field magnet is suddenly switched off at a moment when the magnet is in a state of excitation.* Broadly speaking, as a practical rule, it should be remembered that long concentric cables having transformers lightly loaded connected to their ends should never be suddenly switched into connection with alternators or switched off, but should always be put into connection with the source of E.M.F. through a regulating resistance or inductance, so arranged as to prevent or check the formation of any oscillations of current other than those due to the natural period of the impressed E.M.F. In the early days of the working of many large alternate-current stations many difficulties were experienced owing to the failure of large transformers and the piercing of long concentric cables which were due to these causes, but experience has now shown how to overcome these difficulties, and to prevent any of these disastrous initial effects. In many cases cables and transformers which suddenly fail when switched into connection with the circuit after being idle for a time, have really been injured at the instant when they were last switched out of connection with the working system owing to the rise of potential that has taken place at the instant when the current was interrupted at a particular instant during its phase. Hence the removal of a cable from a working system at the omnibus bar, or at any intermediate point, must always be effected with the same care as the connection of a cable, and in no case should a long concentric cable, whether connected to transformers or not, be switched on or switched off from the live omnibus bars of the station abruptly. This, of course, does not apply so much to short lengths of a few hundred yards as to long lengths of one or more miles, but it behoves the engineer always to be on his guard against these sources of failure.

The time will not allow me now to develop at any greater length these points, and in closing this brief discussion on the construction and action of transformers there is no need to emphasise the fact that much has perforce been omitted owing to the limits of our time, which a complete treatment would necessarily include. I have endeavoured to direct attention rather to a few principal practical considerations, and to portions of the subject not quite elementary in character, and to assume, as I said at the beginning, that the fundamental principles were already familiar to those present.

Great as has been the progress in 10 years in alternate-current working, no one would be so rash to assume that we have reached the limit of its improvement. The practical perfection of the transformer placed in the hands of electrical engineers an instrument of enormous utility and power for effecting the distribution of electric current. Large as may be our indebtedness to those whose scientific and constructive ingenuity has brought about this advance, we must at the same time remember, with due meed of honour and praise, the pioneering experiments of Paul Jablochkoff and Lucien Gaulard in 1887 and 1882, which, even if not the first suggestions for the employment of the induction coil in electric lighting, certainly forced the attention of engineers to consider closely the value and use of that device, and the service it might be brought to render in the solution of the problems of public and private electric supply.

* For further information on these initial effects see "The Alternate Current Transformers," Fleming, new edition, vol. i., p. 201.

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"DYNAMOES." (?)

(See *The Electrician*, July 31, 1896, p. 446, "Load Losses in Dynamoes," by W. M. Mordey).

The innovation comes too late,
The world has learnt the word to spell;
Why fight against the Spelling Fate?
Why shock the readers of the "*El.*"?
Most sounds in spelling don't agree,
But does it matter very much?
Why try to add another "e"?
When dynamos are known as such.
If syntax lies in po-ta-toes,
It's not the same with dynamoes.

The word is known from South to North,
The word is known from East to West;
Where'er an English pen holds forth
The plural is by "s" expressed.
From past decades till time to come,
When men shall store the solar ray;
When dynamos have ceased to hum,
They'll spell it as we do to-day.
That work is slack, one must suppose,
When people gird at dynamose.

If spelling cranks would gain repute,
They'd use the −, not the +;
And find for words the cubest √,
To save our time in writing, thus—
Let c/c, a/c, dy, alt, mo,
Or even signs be used instead,
'Twould knock ·6 off "dynamo,"
And give more time for beer and bed.
Let's hope a fashion comes and grows,
For *shortening* words like dynamows.

J. H. C. B.

LOCOMOTIVES ON HIGHWAYS ACT, 1896.

The following is the text of the new Act to amend the law with respect to the use of locomotives on highways, passed August 14, 1896:

Be it enacted by the Queen's most Excellent Majesty, by and with the advice and consent of the Lords Spiritual and Temporal, and Commons, in this present Parliament assembled, and by the authority of the same, as follows:

1.—(1) The enactments mentioned in the schedule to this Act, and any other enactment restricting the use of locomotives on highways and contained in any public general or local and personal Act in force at the passing of this Act, shall not apply to any vehicle propelled by mechanical power if it is under three tons in weight unladen, and is not used for the purpose of drawing more than one vehicle (such vehicle with its locomotive not to exceed in weight unladen four tons), and is so constructed that no smoke or visible vapour is emitted therefrom except from any temporary or accidental cause; and vehicles so exempted, whether locomotives or drawn by locomotives, are in this Act referred to as light locomotives. Provided that (*a*) the council of any county or county borough shall have power to make by-laws preventing or restricting the use of such locomotives upon any bridge within their area, where such council are satisfied that such use would be attended with damage to the bridge or danger to the public; (*b*) a light locomotive shall be deemed to be a carriage within the meaning of any Act of Parliament, whether public, general, or local, and of any rule, regulation, or by-law made under any Act of Parliament, and if used as a carriage of any particular class shall be deemed to be a carriage of that class, and the law relating to carriages of that class shall apply accordingly. (2) In calculating for the purposes of this Act the weight of a vehicle unladen, the weight of any water, fuel, or accumulators, used for the purpose of propulsion, shall not be included.

2. During the period between one hour after sunset and one hour before sunrise, the person in charge of a light locomotive shall carry attached thereto a lamp so constructed and placed as to exhibit a light in accordance with the regulations to be made by the Local Government Board.

3. Every light locomotive shall carry a bell or other instrument capable of giving audible and sufficient warning of the approach or position of the carriage.

4. No light locomotive shall travel along a public highway at a greater speed than 14 miles an hour, or than any less speed that may be prescribed by regulations of the Local Government Board.

5.—The keeping and use of petroleum or any other inflammable liquid or fuel for the purpose of light locomotives shall be subject to regulations made by a Secretary of State, and regulations so made shall have effect notwithstanding anything in the Petroleum Acts, 1871 to 1881.

6.—(1) The Local Government Board may make regulations with respect to the use of light locomotives on highways, and their construction, and the conditions under which they may be used. (2) Regulations under this section may, if the Local Government Board deem it necessary, be of a local nature and limited in their application to a particular area, and may, on the application of any local authority, prohibit or restrict the use of locomotives for purposes of traction in crowded streets, or in other places where such use may be attended with danger to the public. All regulations under this section shall have full effect notwithstanding anything in any other Act, whether general or local, or any by-laws or regulations made thereunder. Every regulation purporting to be made in pursuance of this section shall be forthwith laid before both Houses of Parliament.

7.—A breach of any by-law or regulation made under this Act or of any provision of this Act may, on summary conviction, be punished by a fine not exceeding £10.

8.—(1) On and after January 1 next after the passing of this Act there shall be granted, charged, and paid in Great Britain for every light locomotive, which is liable to duty either as a carriage or as a hackney carriage under Section 4 of the Customs and Inland Revenue Act, 1888, an additional duty of excise at the following rate—namely, if the weight of the locomotive exceeds one ton unladen, but does not exceed two tons unladen, £2. 2s.; if the weight of the locomotive exceeds two tons unladen, £3. 3s. (2) Every such duty shall be paid, together with the duty on the license for the locomotive, as a carriage or a hackney carriage, and shall in England be dealt with in manner directed with respect to duties on local taxation licenses within the meaning of the Local Government Act, 1888; and in Scotland be paid into the Local Taxation (Scotland) Account, and be dealt with as part of the residue within the meaning of Section 2, Subsection (3), of the Local Taxation (Customs and Excise) Act, 1890.

9. The requirements of sub-section (4) of Section 28 of the Highways and Locomotives Amendment Act, 1878, may be from time to time varied by order of the Local Government Board.

10. In the application of this Act to Scotland, a reference to the Secretary for Scotland shall be substituted for a reference to the Local Government Board, a reference to the road authority of any county or burgh for a reference to the council of a county or county borough, and a reference to Sub-section (4) of Section 3 of the Locomotives Amendment (Scotland) Act, 1878, for a reference to Sub-section (4) of Section 28 of the Highways and Locomotives Amendment Act, 1878.

11. In the application of this Act to Ireland a reference to the Local Government Board for Ireland shall be substituted for a reference to the Local Government Board, and a reference to the council of a county shall be construed in an urban sanitary district under the Public Health (Ireland) Act, 1878, as a reference to the urban sanitary authority, and elsewhere as a reference to the grand jury.

12. This Act may be cited as the Locomotives on Highways Act, 1896, and shall come into operation on the expiration of three months from the passing thereof.

THE MANCHESTER REGULATIONS.

Mr. C. H. Wordingham has kindly forwarded to us a copy of the revised regulations as to the supply of electric current in Manchester. The revision was required owing to the departure of using a 200-volt supply in certain districts with a three-wire system having 400 volts between the two outside wires. The rules applying to motor work have also been remodeled. We give the following extracted clauses, which are more or less new, as interesting to central-station engineers:

1. *Pressure of Supply.*—Electricity for purposes other than motive power will be supplied, at the option of the consumer, at the pressure of 100, 200, 300, or 400 volts (except in those districts where the declared pressure is 200 volts, when it will be supplied, at the option of the consumer, at a pressure of 200 or 400 volts). The pressure at which electricity is supplied for motive power will be determined by regulation No. 34. Except by special arrangement not more than 50 amperes may be supplied at 100 volts, nor more than 25 amperes at a pressure of 200 volts from a single pair of service terminals. When more current is to be supplied the lamps or other consuming devices must be divided between the different pairs of the supply mains. If this rule be departed from there is danger that the pressure of the supply will not be so uniform as it should be. The installation must be divided up into circuits of not more than 50 amperes each even when the current exceeds 200 amperes. When the first application is for a supply of current amounting to nearly 50 amperes it is advisable, if there is any possibility of extension, to divide the lamps into two separate circuits, so that additional lamps may be added on either circuit

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without further breaking up of the street for additional service mains. In the above remarks where the pressure of supply is 200 volts for 50 amperes read 25 amperes.

28. *Starting of Motors.*—All motors must be provided with a switch and starting resistance to be approved by the Corporation's engineer, and to be such that in no case can the current through the motor, when the switch is on the first contact, exceed 10 amperes, or increase by greater steps than 10 amperes at a time as the starting resistance is cut out. This starting switch must be so arranged that it can only be moved very slowly.

29. *Cut-off Switch for Motors.*—The supply to every motor must be controlled by means of an efficient double-pole cut-off switch, placed in such a position as to be easily handled by the person in charge of the motor, and connected so that by its means all pressure can be cut off from the motor itself and from any regulating switch, resistance, or other device in connection therewith.

30. *Cut-outs and Motors.*—An efficient fuse or other automatic cut-out must be provided on each pole so as to efficiently protect the branch circuit to every motor from excess of current; except in the case where motors are supplied at a pressure of 100 volts, two separate cut-outs, and not a double-pole cut-out must be used, and the clear distance between the contact pieces of the cut-out must be not less than 2½in.

32. *Conductors for 400-volt Motors.*—In the case of motors supplied at a pressure of 400 volts the conductors must be enclosed in strong metal casing efficiently connected with earth. The conductors must be insulated in the manner described in Regulation No. 15, except that they must have an insulation resistance of not less than 2,500 megohms per mile when tested after one minute's electrification.

33. *Framework of Motors to be Connected to Earth.* — The magnets, frame, and shaft of all motors must be permanently connected to earth by a copper conductor having a sectional area of not less than 10 square millimetres.

34. *Pressure of Supply to Motors* —Electricity will be supplied to motors at the following pressures: 100 volts for motors absorbing not more than 750 watts; 200 volts for motors absorbing from 750 to 4,000 watts; 400 volts for motors exceeding 4,000 watts.

200-Volt Supply.—In those cases where the declared pressure is 200 volts, the following regulations must be conformed to in addition to those enumerated above:

38. *Two Single-Pole Cut-Outs to be Fixed.*—Two single-pole cut-outs must be fixed instead of one double-pole cut out in all cases.

39 *Length of Break in Cut-Outs.*—The clear distance between the contact pieces of the cut out must be not less than 1in. for fuses intended to melt with currents not exceeding five amperes, and not less than 1½in. for those intended to melt with currents greater than five amperes.

40. *Distribution Boards and Cut-Outs.*—Distribution boards are greatly preferred to separate cut-outs, but where these latter are employed there must be a clear distance between the interior surface of the cover and any portion of the metal work of 1½in.

41. *Ceiling Roses.*—Fuses must on no account be fixed within ceiling roses, but separate cut-outs must be provided unless distribution boards are used. In this latter case, if the lamps are divided into circuits taking not more than three amperes, separate cut-outs need not be fixed for each lamp.

42. *Length in Break in Switches.*—The clear break in all switches must be not less than 1in, and for switches intended to break more than five amperes the clear break must be not less than 1½in.

43. *Key Sockets Not to be Used.*—No combination switch and fitting or key sockets must be employed.

LEGAL INTELLIGENCE.

THE CHARACTER OF LEAD OXIDES.

In the Lord Mayor's Court last week, before Mr. Roxburgh (assistant judge) and a common jury, the case of the Farringdon Works, Limited *v.* the I. E. S. Accumulator Company, Limited, came on.

This was an action to recover £52. 13s. 9d. for goods sold and delivered. The defendants pleaded "never indebted," and counterclaimed for damages, alleging that the plaintiffs contracted to supply them with five tons of oxide of lead, but they only delivered two tons, which were not according to contract, and by reason of which defendants suffered damage. Mr. Crispe appeared for the plaintiffs, and Mr. C. C. Scott for the defendants.

Mr. Crispe, in opening, said the defendant company required, for the purpose of application to their plates, a compound which was called red oxide, and was, apparently, a mixture of an ordinary red lead and litharge. The defendants had a secret in regard to the proportions in which the red lead and the litharge were to be mixed. The plaintiffs had supplied them with red oxide which they obtained from Messrs. Walker, Parker, and Co, the manufacturers, who had been previously instructed by the defendants as to the mode of preparing the compounds. On April 23 defendants sent the plaintiffs an order "for five tons of oxide as before." The two tons of oxide were duly delivered, the invoice price being £35. There was a balance due on a previous account of £17. 13s. 9d., bringing up the amount to £52. 13s. 9d. Credit had been given for £30 paid on May 21, and the balance, £22. 13s. 9d., had not been paid; hence the action. The defendants refused payment on the ground that the oxide supplied was not according to contract. After delivery they telegraphed, "The last two tons of oxide no good; all plates spoiled; send some more at once" The plaintiffs, not being manufacturers, referred to the works, and were told that the oxide complained of was of exactly the same quality as that previously supplied, and had been manufactured precisely in the same way. The plaintiffs could only assume, therefore, that whatever defect there was was due to some fault on the part of the defendants themselves

Mr. Arthur Billyeald, manager to Messrs Walker, Parker, and Co., gave evidence to the effect that the oxide supplied was exactly similar to that previously delivered, and was mixed in accordance with the instructions given by the expert of the defendant company.

Mr. Scott said the defendants declined payment on the ground that the stuff supplied was absolutely useless to them, and counterclaimed for damages by reason of the defective condition of the oxide. The material required was used for accumulators. It was mixed in certain proportions with sulphuric acid, and so formed a cement with which the plates were covered. If the red oxide and litharge were mixed in proper proportions, it would, when treated with diluted sulphuric acid, form a binding cement. The plaintiffs had supplied the defendants with a sample of the stuff which they were prepared to supply, and executed an order to sample, but the second order was not "as before," and did not make a binding material when mixed with sulphuric acid, and a quantity of plates were rendered useless. Defendants consequently declined payment, and counterclaimed for the money which they had lost.

Mr. J. Digby, manager of the defendant company, and **Mr. P. J. Bunn**, their foreman, gave evidence bearing out this statement.

Mr. Crispe called rebutting evidence. His witnesses included **Mr. A. Buckland**, electrical engineer, who said that if care was not taken during the mixing of the oxide with the sulphuric acid to break up any lumps that might be in it, or to get the paste of a proper consistency, the probabilities were that it would not be adhesive.

In the result the jury found for the plaintiffs for the amount claimed.

COMPANIES' MEETINGS AND REPORTS.

CUBA SUBMARINE TELEGRAPH COMPANY, LIMITED.

The half-yearly meeting of this Company was held on Wednesday at the offices in Old Broad-street, Mr. C. W. Parish presiding.

The **Chairman** moved the adoption of the report, which he spoke of as satisfactory. During the past six months the cables had worked well, and the Company had earned a larger sum of money than in any previous half-year of its existence. The gross receipts amounted to £36,186, and the gross expenditure to £9,425, leaving a sum of £26,761, which, added to the balance of £3,719 brought forward from the last account, left £30,481 to the credit of revenue account. The increased traffic and the cost of working the five new stations of the Cienfuegos-Manzanillo cables, which were opened at the commencement of the year, accounted for the increase in the station expenses. The last six months had been a period of anxiety to the Board in consequence of the disturbances in Cuba and the agitation going on among the promoters of fresh cable schemes and new companies. Numerous suggestions were being pressed upon the European Governments to connect their colonies with fresh cables. He thought the necessity for these cables somewhat exaggerated, but the Company should be ready to face any new situation that might arise. Our Government were considering the laying of a cable from Jamaica to Bermuda, but it was a complicated scheme, upon which he had no definite information to give.

The report was adopted.

NORTH STAFFORDSHIRE TRAMWAYS COMPANY, LIMITED.

The ordinary general meeting of this Company was held on Tuesday at the Guildhall Tavern, E.C., Mr. W. J. Carruthers-Wain (the chairman) presiding.

In the course of his speech on the motion for the adoption of the reports and accounts, the **Chairman** said the Act authorising the Company to adopt the new form of traction received the Royal assent only a few days ago, and that had somewhat delayed the negotiations which had been going on for the purpose of applying the electrical system. During the next six months, however, it might be expected that the local authorities would insist upon substantial alterations and improvements being made, and that was one of the reasons why the Board suggested that a considerable sum should be placed to the renewal and reserve fund, so that they might be able to meet the requirements of the local authorities.

The resolution was carried, and dividends were declared for the half-year at the rate of 6 per cent. per annum on the preference shares, and at the rate of 3 per cent. per annum on the ordinary shares.

NEW ZEALAND ELECTRICAL SYNDICATE, LIMITED.

An adjourned ordinary general meeting of this Company was held on Monday at Cannon-street Hotel, E.C., Mr. de Castro presiding.

Before the proceedings commenced, **Mr Huxtable**, on behalf of certain persons, entered a protest against the legality of the

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meeting, which, he said, had not been properly adjourned. He asserted that Messrs. Boustead and Savory had been elected directors in place of Messrs. de Castro and Grewing, who, however, retained office. The meeting was adjourned by a tacit resolution of the shareholders, although Mr. Lewis and himself protested.

The **Chairman**: Then you have your remedy.

The **Secretary** read the minutes of the original meeting, stating that it was adjourned in consequence of there not being a quorum present, and the chairman proceeded to sign them, in spite of a protest from Mr. Huxtable, who said he had the opinion of Mr. Cozens-Hardy, Q.C., to the effect that the election of Messrs. Boustead and Savory to the board was in order.

The **Chairman** said that the directors had been unable to obtain any information from the receiver and manager of the company, who was in possession of all the Company's property and books of account, as to the position of the Company. They were, therefore, unable to present any accounts or any balance-sheet to the shareholders. Under these circumstances both the directors were anxious to retire from the Board, and tendered their resignations to the shareholders; but as the Company might be placed in a very difficult position if they vacated their seats without providing for the election of their successors, they were willing to remain in office until new directors had been elected by some properly-constituted meeting of the shareholders. The Chairman then declared the meeting closed.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Merida (Spain).—The Local Authorities of Merida in the province of Badajoz want tenders by August 25 for the electric lighting of the town.

Nava del Rey (Spain).—The Municipality are open to receive tenders up to August 28 for the electric lighting of Nava del Rey for a period of 20 years.

Paris.—Tenders are wanted by September 8 for the supply of magneto-electric calls for the Departments of Posts and Telegraphs, rue de Grenelle 103, Paris.

Ghent.—Tenders are wanted by M. le Percepteur des Postes, Grand Centre, for telegraphic maintenance work. The date is August 28, and the amount small.

Dantzig.—Tenders are wanted for the supply of incandescent lamps and carbons. Particulars for 75 pf. (9d.) from the Konigliche Direction der Gewehrfabrik, Dantzig.

Dortmund (Germany).—The Municipal Authorities of Dortmund want tenders by September 1 for engines, boilers, and dynamos for the electric lighting of the town.

Spa (Belgium)—The Burgomaster and Echevins of Spa invite propositions for undertaking the public lighting, either electrically or by acetylene. The date fixed is September 15. No further information is given in the official advertisement.

Copenhagen.—Tenders are wanted for the supply of 20,000 incandescent electric lamps. Application should be made to Directeuren for Kjöbenhavens Belysningsväsen, Gothersgade, 30, Copenhagen, and tenders must be in by August 22.

The Hague.—Tenders are wanted by August 24 for the supply to the Dutch Government of iron telegraph posts, galvanised iron wire (telegraphic, insulator pins, etc. Application should be made to the Dutch Colonial Ministry at the Hague.

St. Pancras.—Tenders are wanted for the supply and erection of 80 arc lamp columns about 19ft. high, for the St. Pancras Vestry. Particulars are obtainable at the Vestry's Electric Department Offices, 57, Pratt-street, Camden Town, N.W., and tenders must be in by August 24.

Villefranche-Lauragais (France).—The Municipality of Villefranche-Lauragais (Haute-Garonne) have invited competitive plans for a public water supply and electric lighting. Prizes of 1,000fr., 500fr., and 200fr. are offered, under the usual conditions, and schemes must be sent to the Mairie by October 10.

Cork.—The Corporation of Cork invite tenders for the transfer of their provisional order for electric lighting. The working of this will probably also include the supply of current to an electric tramway. Particulars can be obtained (on the deposit of one guinea) from the Town Clerk, Municipal Buildings, Cork.

Paris.—There is to be a limited competition for the supply of cables for the electric lighting of the Avenue de l'Opéra. The date is August 27. There is also for tender the work of installing the electric light at the College Chaptal, 49, Boulevard de Batignolles. Application must be made immediately to the Hotel de Ville.

Cologne.—Tenders are required by the Municipal Authorities for the construction and working of electric tramways in the city of Cologne to an aggregate length of 20·3 kilometres (12½ miles). Specifications, plans, and particulars are obtainable for 10 marks (10s.) from der Registrateur B, des Oberbürgermeisteramt, Köln, Germany, and tenders must be in by November 6.

Madras.—Tenders are invited for the lighting by electricity of Government House, Madras, including the banqueting-hall and aide-de-camps' bungalow, and also for the lighting of Government House, Guindy, including the military secretary's bungalow. For particulars application must be made to the consulting architect to the Government, Chepank, Madras. Tenders will be opened on November 11, 1896.

Voghera (Italy).—In view of the expiration of their contract with the local gas company in 1898, the municipal authorities of Voghera are desirous of receiving during the present year propositions for the lighting of the town either by the electric light or a mixed system of gas and electricity. The population is 16,000. Application should be made to L'Administrazione Comunale, Voghera, who will give all particulars necessary.

Mayaguez (Puerto Rico).—The Secretary of State for Foreign Affairs has been informed by H.M. Ambassador at Madrid that the Spanish Government have invited tenders for the construction and working of a telephone system in Mayagüez, Puerto Rico. The date fixed for the consideration of tenders is October 8, and such particulars as have been received may be inspected at the Commercial Department of the Foreign Office between the hours of 11 and 6 daily.

Dewsbury.—Tenders are invited by the Governors for the wiring and fitting of the Dewsbury and District Technical School. Copies of specifications may be obtained from the Secretary on payment of £1. 1s., which will be refunded on return of same, accompanied by a bona fide tender. Plans may be seen at the office of the Secretary, from whom any further information can be obtained. Sealed tenders must be sent to Mr. P. F. Lee, secretary, endorsed "Electric Lighting," by 22nd inst.

Southampton.—The Harbour Board invite tenders for the construction and erection of four electric cranes and accessories, and also for alterations to a gantry of an existing crane, on the Town Quay, Southampton. Specification, with two general drawings attached, may be obtained on and after 20th inst. from Mr. A. H Skelton, clerk, Town Quay, Southampton, upon payment of £3. 3s., which will not be returned, and further detailed plans may be seen at the office of the electrical engineer, Mr. J. G. W. Aldridge, 9, Victoria-street, Westminster, S.W. Sealed tenders, marked "Tenders for Electric Cranes," should be sent to the clerk by August 31.

Jassy.—The Mayoralty of the Town of Jassy (Roumania) has given notice that on August 23, 1896, old style (by our reckoning September 4), tenders will be received, for the second time, in the hall of the Municipal Council, for "the installation of a frigorific hall, electric light, and various accessories requisite for new public slaughter-houses. Offers must be in accordance with the specification, the conditions of contract, the special conditions, and the plans deposited in the offices of the director of the slaughter-house works, where particulars may be obtained." Tenders are to be enclosed in sealed envelopes, marked "Offre pour l'installation de la Hall Frigorifique," and senders of tenders must abide by articles 68-79 of the Roumanian Public Accounts Act. All tenders and supplementary documents must be in either the Roumanian or French language.

Cadiz.—The Secretary of State for Foreign Affairs has received dispatches from her Majesty's Consul at Cadiz, stating that preliminary tenders for a supply of electric lighting apparatus for the illumination, on the most approved modern plan, of private houses, etc., in the town of Cadiz are invited by the "Sociedad Co-operativa Gaditana de Fabricacion de Gas." It appears that the tenders should be sent in by September 15 to the above-named company, whose offices are San José, 25, 27, and 29, Cadiz. Firms wishing to obtain the contract for the supply of plant are advised by the Consul to send representatives to treat personally with the company. Such additional particulars as have reached her Majesty's Government on the subject may be viewed at the Commercial Department of the Foreign Office, any day between the hours of 11 a.m. and 6 p.m.

Bath.—The Corporation invite tenders for the supply and erection of the following plant:—Section A: Boiler and fittings, feed pump, etc. Section B: Steam alternators, oil-filter, fittings, etc., steam, exhaust, feed, blow-off, and sundry pipes, valves, etc. Section C: Mains. Section D: Crane. Section E: Arc lamps and posts. Tenderers are at liberty to tender for either section, but not for part of a section. The ground plan of plant and specification, with terms and conditions of tender and contract, may be obtained at the office of Mr. Robert Hammond, the consulting engineer, Ormond House, Great Trinity-lane, E.C., on and after the 13th inst., on payment of £2. 2s., which will be returned on receipt of a bona fide tender. Sealed tenders, marked "Tender for Electric Lighting," must be addressed to Mr. F. H. Moger, clerk, 3, Wood-street, Bath, and delivered by the 31st inst.

RESULTS OF TENDERS.

Walsall.—For providing and fixing a water-tube boiler at the electricity station, for the Town Council, the tender of Messrs. Babcock and Wilcox, at £486. 10s., has been accepted.

Southend.—Messrs. Lowe and Hoad's tender of £15. 15s. for fixing a telephone between the medical officer's residence and the sanitorium has been recommended for acceptance by the Town Council.

Tournai.—The lowest tender for generating station buildings at the Tournai Asylum on August 8 was that of Messrs. L. Bariseau at 10,977fr. The estimate was 13,300fr., and all the tenders were below this.

Brussels.—The contract for the construction, maintenance, and working of an electric tramway from the Rue Gerard to the Bois de la Cambre, for the local authorities, has been placed with the Tramways Bruxellois.

Whitehaven.—The Town Council have accepted the tender of the Lowca Engineering Company for the purchase of the donkey engine at the electric lighting station. One other firm tendered. The price is not given.

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BUSINESS NOTES.

Newbury.—The dynamo room at Dean Wood has been destroyed by fire.

Llanelly.—The electric lighting question has been discussed and adjourned.

Western and Brazilian Telegraph Company.—For the past week the receipts were £2,744.

Santiago (Chile).—The Municipal Council have been considering the conditions on which tenders should be invited for a scheme of electric lighting.

Bury St. Edmunds.—The Ratepayers' Association have held a demonstration against the Town Council adopting an electric lighting scheme.

West India and Panama Telegraph Company.—For the half-month ended August 15 the receipts were £1,704, as against £1,660 for the corresponding period of 1895.

A'derley Edge.—After some discussion, the Urban District Council have given the chairman power to complete the transfer to the Council of the electric lighting order.

Colwall (Hereford).—The Parish Council have appointed a committee "to make enquiries and report as to having a telephone exchange at Colwall." The population is 1,400.

Monte Video.—A project has been presented to the Monte Video (Uruguay) Municipality for an electric tramway from that city to Colon along the new high road lately constructed.

Market Deeping.—The local Council have refused the offer of the gas company to light the town with gas from September 1 to April 1 for £130, but what, if any, other means of illumination is contemplated is not stated.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending August 16 amounted to £1,375, as compared with £1,374 in the corresponding week of the previous year, being an increase of £1.

Dover.—On the occasion of the installation of the Marquis of Salisbury as Lord Warden of the Cinque Ports the street decorations were very elaborate, and the sea front was lined out round the entire bay with electric lamps.

Motor Car Syndicate of Australia, Limited.—This is a Company which has been registered, with a capital of £5,000 in £1 shares, to manufacture, sell, and deal in "auto-motorcars," carriages, tramcars, cycles, ships, etc.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ending August 14 were £2,376. 17s. 7d., compared with £1,938. 9s. 1d. for the corresponding period of last year, being an increase of £438. 8s. 6d.

Dundee.—It has been explained, with reference to the staffing of the electrical department, that the increase in the subordinate staff resolved on by the committee only means that a switcher at a wage of 30s. a week, and another man at 15s is to be added.

Bedford.—The St. Paul's Wesleyan Chapel has been reopened. The old gas brackets have given way to the electric light, the installation of which was entrusted to Messrs. Kilpin and Bilson. This is the first place of worship in Bedford to utilise the light.

Kirkby Lonsdale.—Mr. A. M. Harris has submitted to the Urban District Council an estimate for an electric lighting supply, but as the Council is treating with the gasworks for the purchase of their undertaking it is not probable that much will come of it.

The Brush Company.—Notice has been given that the transfer books of the first debenture stock of the Brush Electrical Engineering Company, Limited, will, in view of interest payable on September 1, 1896, be closed from August 19, 1896, to September 1, 1896, both inclusive.

City and South London Railway.—The returns for the week ended August 16 were £1,110, compared with £924 for the corresponding period of last year, being an increase of £186. The total receipts for the half-year 1896 were £6,529, compared with £6,008 last year, being an increase of £521.

Motors, Limited.—This is the name of a company registered by Thomas Durant, 5, Guildhall chambers, E.C., with a capital of £5,000 in £1 shares, to enter into an agreement with S. L. Phillips and to carry on business as electricians, mechanical engineers, etc. The office is at 12, Camomile street, E.C.

River Plate Electric Light and Traction Company, Limited.—The River Plate Trust, Loan, and Agency Company notify that the scrip of the issue of £125,000 5 per cent. first debenture stock is now ready, and can be had at their offices, 52, Moorgate-street, E.C., in exchange for the allotment letters duly endorsed.

Bolton.—At a meeting of the Gas and Electricity Committee it was reported that the receipts from electricity consumption for the past year amounted to £1 689. 2s. 8d., as against £694. 14s. 8d. for last year. There were now 155 consumers of electricity as against 70 last year, and there are applications from 13 new customers

Halstead (Essex).—The surveyor reported to the Urban District Council that Messrs. Crompton's agent had visited the town on the subject of an arrangement for introducing the electric light, and would send in his report in due course. Mr. Carter remarked that the agent thought the matter was well received by the people.

Manlove, Alliott, and Co, Limited.—This is a new Company, registered with a capital of £150,000 in £10 shares, to carry into effect an agreement with Manlove, Alliott, and Co., Limited (the old company, incorporated in 1888), and the liquidator thereof, for the acquisition, as a going concern, of the business, assets, and liabilities.

Inverness.—At a meeting of the Town Council Provost MacBean moved that the Council oppose the application by a London electric lighting company for a provisional order for the electric lighting of Inverness as the Council, as Gas Commissioners, were quite capable of supplying any artificial light, whether electric or other. The motion was adopted.

Appointments Vacant.—The Hammersmith Vestry want a resident electrical engineer. The salary is to be £200 a year, and £250 when the works are finished and running. Application should be made to the Vestry Clerk, at 57, Fulham Palace-road.—The Lancaster Corporation require a dynamo and switchboard attendant at 25s. a week. Application is to be made to the Town Clerk.

Withington.—At the Urban District Council the minutes of the General Purposes Committee, which were approved, stated that they had had under consideration the adoption of electric lighting, and that it had been decided to send a postcard to the owners and occupiers of all houses of a rental of £30 and upwards asking whether they were in favour of the project; also that a report on the whole question would be prepared and laid before the Council.

Croydon.—The Chairman of the Tramways Company, Mr. C. Wain, speaking at the general meeting on the subject of electric traction, said although he believed in electricity, gas, oil, and many other things which were going to be the motors of the future, he was of the opinion that there was a good deal left in the horse yet. For the present they must be content to go along with horse-power.

Douglas (Isle of Man).—At the Town Council a proposal to enter into a contract for the adoption for five years of incandescent gas lighting for the whole town was submitted, and was met by an amendment that the matter be deferred with a view to considering the question of lighting the town by electricity. It was decided ultimately that the subject be reconsidered before any system was selected.

New Addresses.—Mr. F. J. Warden Stevens informs us that he has found it necessary to remove from Martin's-chambers, Cannon-street, E.C., to larger offices at Connaught-mansions, 34, Victoria-street, Westminster, S.W. His country offices will remain at Town Hall-chambers, Guildford.—Mr. J. S. Cunnington has removed from John-street, Adelphi, to larger premises at 18, Cecil-court, Charing Cross-road, W.C.

Radcliffe.—The minutes of the meeting of the Electric Lighting Sub-Committee contained a resolution recommending the Electric Lighting Committee to grant to the clerk an honorarium of £20 in consideration of the extra services rendered by him in obtaining the provisional order. There was some discussion on this in the full Council, and the matter was left over until it had been reported to the Electric Lighting Committee.

Ripon.—At Studley Royal, the seat of the Marquis of Ripon, without waiting for other people, or heeding the good reasons and good taste which are understood to have prevented any such display elsewhere at present, they have begun the celebration of the sixtieth year of the present reign. The only point of interest so far as we are concerned is, however, that, as part of the celebration, at night the town was illuminated by electricity.

Pulleys and Shafts.—We have to acknowledge the receipt from Messrs. J. Bagshaw and Sons, Limited, of Batley, of their rules and tables for engineers and architects. The book is, of course, a catalogue and price-list of Messrs. Bagshaw's manufactures, but it contains a large amount of information on the subject of the transmission of power by shafting and belts, and there are also tables of safe loads for iron girders, weights of bar iron, etc.

The Electrical Trades Union.—We are requested by Mr. J. E. Sims, the organising secretary of the above union, to announce that a meeting will be held on Monday, 24th inst., at 8.30 p.m. This will be addressed by Mr. Sims, who will explain the object of the trade combination and the benefits expected to accrue to the members. The meeting will be held at the Club and Institute Buildings, Clerkenwell-road, E.C., and all electrical workmen are invited.

Anglo-French Motor Carriage Company, Limited. — This Company has been registered, with a capital of £300,000 in £1 shares, to adopt an agreement with E. Rogers and to carry on business as manufacturers of and dealers in motors and motorcars, etc., and as manufacturers of steam, gas, oil, and electric engines, motors and dynamos, and builders of launches; as mechanical and electrical engineers, and to construct tram roads. The registered office is 58, Coleman-street, E C.

Metropolitan Electric Supply.—The *Financial Times* says it has received bitter complaints by private customers of the Metropolitan Electric Supply Company because the company has reduced the price of lighting to shops and business premises owing to the competition of the Charing Cross and Strand Electricity Supply Company, while it has made no similar concession to the occupiers of dwelling-houses. That somebody else is being benefited does not seem very substantial ground of complaint.

Central London Railway.—At the London Sheriffs' Court, on the compensation claim coming on of Mr. Robert William Clarke, an ironmonger at Bayswater, who sought to recover from the Central London Railway Company £12,500 as compensation for

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the compulsory acquirement of his premises, situate at 1, Coburg-road, and 1, Queen's-road, Bayswater, for the purposes of the construction of their new line, a consultation between counsel ensued, with the result that it was agreed to enter a verdict for the claimant for £6,500.

City of London Electric Lighting Company, Limited.—The revenue return for the quarter ended June shows an increase of £4,718, the gross returns from public lighting being £3,189, against £3,202 last year, and from private lighting £16,564, against £12,283, and from other sources (estimated) £650, against £200. The equivalent of 8-c.p. lamps connected on June 24, 1896, was 215,559, being an increase during the quarter of 8,291. The corresponding figures for the same quarter in the previous year were 159,250 and 10,656.

Brighton.—The large sea-going car for the Rottingdean Electric Railway is now erected, and has been tried. As soon as the necessary connections were made, and the current from Volk's Electric Railway turned on, the car at once started, the control over its movements being absolute. The remainder of the overhead wire is now being erected, and after inspection by the Board of Trade the line will be opened for traffic. Very little remains to be done, the machinery at Rottingdean Pier is fixed, and nearly ready to start. The car is standing close to Paston-place jetty, and can be examined there.

St. George's, Hanover-square (London).—The Electric Lighting Committee have considered a letter from St. James's (Westminster) stating that that Vestry proposed erecting five electric light lamps, at a cost of about £38 each, in the centre of the roadway of Piccadilly and St. James's-street, and expressing a hope that, as a portion of the streets to be lighted is in St. George's, the Vestry would consent to contribute one half of the cost. Mr. Macdonald moved that they assent to the request of the St. James's Vestry. Mr. Burch objected; St. George's was to find the money, but St. James's would control it, and the motion was rejected by 15 votes to 7.

Taunton.—The electrical engineer (Mr. Harold W. Couzens, A I.E.E) has presented his quarterly report, as follows: "I have the honour to report that during the past quarter there has been a satisfactory increase in our lamp connection—92 lamps (of 16 c.p) having been installed and a further 84 applied for. We have been busily engaged with the many and varying details incident to the changing over the remainder of our supply to the underground conductors; these will be very shortly completed, and we shall then remove the overhead wires at once. The machinery, plant, and apparatus has been maintained at its thorough state of efficiency."

Boston (Lincolnshire).—At the Town Council meeting Mr. Pooles asked whether any report had been received from the Paving and Lighting Committee with reference to the electric light. The Mayor said the committee had appointed a sub-committee to gather information on the subject. Mr. Waddington hoped sufficient time would be given to enable the shareholders in the gas company to sell out, and Alderman Bedford said the matter would require a great deal of consideration, and he hoped the committee would be exceedingly careful in dealing with it. He was not a shareholder in the gas company, and therefore he was unprejudiced in the matter.

Warminster.—Mr. Mark Hlils' reply to the Town Council's offer in reference to the electric lighting account, reiterates his claim, and adds: "I lost at least £100 by it (the lighting), and can prove it; but in order to meet you I offer to take £50, without prejudice, in settlement of my claim against you, which was a reasonable one. I shall not allow the cable to be removed until my claim has been paid, and unless that is done at once, I shall instruct Messrs. Cruttwell and Daniell to issue a writ for my out-of-pocket expenses, which are £100." The difficulty appears to have arisen from individual members of the Council making verbal representations as to what that body would be willing to do. No resolution was come to.

Ealing.—The surveyor has reported that the number of lamps, including 600 8 c.p. lamps at Gunnersbury, was now 8,771 and by the end of the month would be 9,000. Of this number 7,754 were actually connected with the mains upon the 5,000 lamp installation. He hoped that all the present difficulties would speedily be overcome. One of the two new engines had been in working order for the past three days, and it had turned out as satisfactorily as could be expected. The engine power at the works was now in excess of the boiler power, and the Electric Lighting Committee accordingly recommended the purchase of a new boiler at a cost of £500. This was unanimously agreed to by the Urban District Council.

Hunstanton.—At a meeting of the Urban District Council Mr. Beeton proposed the motion of which he had given notice, to take into consideration the question of an electric light supply within the limits of the district. He merely wished to ventilate the subject and then suggest its postponement to a future meeting. The electric light would be cheaper, and would ease the gas-works, as he thought the plant of the company was hardly sufficient for the wants of the town in the season. The engine they would use for the light would also be available for sewerage, and for pumping sea water for use in watering roads. Several members agreed that the supply of gas for the past few weeks had been insufficient, but the subject was dropped without any resolution being arrived at.

Liverpool.—Mr. Holme, electrical engineer, having prepared a report on the question of the proposed reduction of charges for electric lighting, after this had been read and discussed the Lighting Committee decided to recommend the Council to sanction the following reductions: meter rents from 2s. to 1s. per month, and in place of the existing uniform charge of 7½d. per unit that a scale as follows be adopted on and after October 1—for each unit up to 1,000 per month, 7d. per unit; for each unit in excess of 1,000 per month, 4d.; that the charge for electrical energy for heating, cooking, etc., when supplied through a separate meter, be reduced from 5d. to 4d per unit; and that consumers occupying two or more places of business be allowed to have them included as one item.

Greenwich.—At the general meeting of the London, Deptford, and Greenwich Tramways Company Mr. W. J. Carruthers-Wain (the chairman) said as to the possibilities of the future as regards traction, though he went all over America for the third time last autumn, and saw one or two systems supposed to be good for crowded thoroughfares and heavy traffic, he did not really see—subject, of course, to the improvements that had been made since—anything that would be suitable for the Greenwich line. They had tried the Connolly motor, the oil engine; had tried compressed gas as well, and had also given consideration to the question of the new motor, the company to work which was launched the other day—namely, the Zurich gas motor—on some of our tramways for some little time. They must wait a little while longer before doing anything.

Eccles (Lancs.).—The Local Government Board have declined to sanction borrowing powers for £20,000 to enable the Town Council to carry out its electric lighting scheme. It will be remembered that Mr. G. W. Willcocks, M.I.C.E., held an enquiry at the Town Hall in June, when considerable opposition was raised to the application by some members of the Council and the Eccles Property Owners' and Ratepayers' Associations. The enquiry lasted two days, and at the hearing the town clerk informed the Commissioner that the Board of Trade had agreed to extend the provisional order for 12 months from June 12. The scheme has been the subject also of much opposition at the Council meetings, and was only carried by the casting vote of the Mayor. Since then two members have been elected to oppose the scheme, so that there is a majority of dissentients now on the Council.

Portsmouth.—The Finance Committee recommended that proceedings should be instituted by the Town Council against the Portsea Island Gaslight Company for having supplied the borough with gas of less illuminating power and less purity than prescribed. Mr. Scarrott moved that the clause be referred back, saying that the prosecution was suggested by the jealousy of the Electric Light Committee. During the discussion the Town Clerk said the gas company disputed the accuracy of the test. The amendment was, however, lost, and the prosecution ordered. The Electric Light Committee recommended that motors and ovens be let on hire to consumers at 15 per cent. on the cost price; also that the Baths and Wash-houses Committee should be charged for the current at the rate of 2½d. per unit during the day only, and these recommendations were adopted.

Thorne (Yorks).—At the Board of Guardians the Clerk stated that he had had a visit from a representative of the National Telephone Company, the company being desirous of fixing a wire to the chimney of the Thorne Union Workhouse, and agreeing to pay 1s. per year acknowledgment. Mr. Standring thought it would be a favourable opportunity for making terms for the clerk to have a telephone at a reasonable cost. Mr. J. J. S. Clarke said that if the wire were affixed to the chimney it would be a nuisance. When the wire was repaired the workmen would disturb the tiles on the building, which would allow water to percolate through the roofs. At any rate, that had been his experience. Mr. Cooper concurred, adding that such had really been the case at Hatfield. Mr. Clarke pointed out that the nuisance was rendered greater by the continuous humming. Mr. Standring suggested that probably the requirements of the Telephone Company would be met if they were allowed to fix a post, and this was agreed to.

Blackpool.—The Town Council will proceed at once with the construction of tramways from the south end of Cookson-street, along Raikes-road, Whitegate-lane, and Cowgap-lane to Lytham-road. At the next session of Parliament, the town clerk is authorised to promote the provisional order for tramway extensions to complete the entire circle from Queen-street, along Parker-street, Abingdon-street, to the south end of Cookson-street. This will complete the scheme, and every part of the town will then be brought into close connection with every other, and a girdle of tramways will encircle the town from Talbot square round by Marton and the Promenade back again to Talbot-square. For this work the overhead system is to be adopted, instead of the conduit system now in use on the Promenade. As to the electric lighting, it is stated that the new engineer, Mr. Quinn, is asking for nearly £10,000, chiefly for laying new mains, and that an alteration is contemplated in the system of supply.

Yarmouth.—The surveyor reported to the Town Council that seven more customers had been secured for 655 lamps, the total now being 184 for 9,020 lamps. The income in July amounted to £150. 6s. 8d., while the cost of production was £136. 9s. 11d., leaving a balance of £13. 16s. 9d. to meet capital and interest charges of £130 per month. A memorial was read from the secretaries of seven places of worship asking that a reduction should be made in the charge for the supply of current to their buildings, pointing out that such supply would largely be required during the time that a light load was being sent out from the works. The Electric Lighting Committee decided that the application should stand over until the undertaking had become more remunerative. An amendment was moved that the last paragraph be referred back, on the ground that it would be a good thing to get the light into the churches, where it would be

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chiefly used on Sunday evenings. Mr. Martins said the objection was that the churches would require the light on weekday evenings as well, when the machinery was being worked at high pressure, but the amendment was agreed to.

Dewsbury.—At the Lighting Committee the electrician reported that 1,534 units of electric energy had been discharged (this is apparently the Dewsbury form of report) during the fortnight ended July 4, against 584 units for the corresponding period last year. The gas manager also reported the distribution of 3 692 000 cubic feet of gas for the same period, against 3 846,500 last year. It was resolved that the borough accountant transfer £1,000 from the electric lighting account to the gasworks capital account as the purchase price for the site of the electric lighting works. At a subsequent meeting the electrician reported that the electric energy discharged during the fortnight ended July 18 was 1,658 units, against 562 last year. The gas manager reported that for the same period 3,866,500 cubic feet of gas had been distributed, against 4,076 000 last year. The electrician was instructed to get further information with respect to the supply of cable for the extension of the electric mains to the technical school, and that the chairman, vice-chairman, and Councillors Oldroyd and Phillips should be empowered to accept any tender they may consider desirable. The report of the committee was adopted by the Town Council.

Hull.—It will be remembered that the Town Council by a small majority rejected the recommendation of the Electric Lighting Committee for a new generating station. At a new meeting of the committee applications for the supply of electric light were received from Messrs. Hammond and Co , Osborne-street, and Mr. Robinson, Charlotte-street. Dr. Kessen and Alderman Hall expressed themselves favorable to these firms being supplied with the light, though in the case of Messrs. Hammond it would mean an expenditure of £60 for additional mains, and of £250 for a main to serve Mr. Robinson. Mr. Crook objected to such items of expenditure, contending that the committee should comprehensively light the town with electricity. The engineer explained that there were now 23,414 lamps connected to the present station, and the maximum output was between 19,000 and 20,000 lamps. Mr. Parrott said this strengthened the case of the committee for an extension, because from the engineer's figures they had already exceeded their maximum power of supply. It was resolved to inform the applicants that the committee regretted that owing to the demand upon the present station they were unable to comply with the request. An application was also received from the manager of the Grosvenor Hotel asking for a supply. Ultimately Alderman Hall moved that the committee re-affirm their conviction that it was necessary to provide additional generating plant. Mr. Hanger seconded the motion, which was carried. It was then agreed on the motion of Alderman Hall, seconded by Mr. Hanger, to engage a consulting engineer, to advise and report on the whole matter.

Southampton.—In reference to the purchase of land at the electric lighting station, the town clerk submitted letters to the committee from Messrs. Kincaid, Waller, and Manville, the consulting electrical engineers of the Corporation, asking whether, in completing the contract drawings, they were right in assuming that the Corporation would be able to obtain the additional land to the north side of the site. The town clerk also submitted an offer in writing from the owners of the land to sell to the Corporation the whole of the land at the price of £5,890 It was resolved that the town clerk be authorised to offer a price not exceeding £5,300. At a subsequent meeting the town clerk reported that this was accepted, and the committee recommended the Council to apply to the Local Government Board for sanction to borrow the sum of £5 300, in addition to the sum of £50 000, in connection with the electric lighting undertaking. Alderman Bone, moved the adoption of the committee's report. Mr McDonnell said he was surprised that the Council were asked to vote £5,300 in respect of the electric lighting undertaking so soon, as they had allowed a large margin in granting the main purchase money, which they were told at the time was sufficient to provide for all emergencies. The committee's report was adopted. There was a long discussion on the Works and Fire Brigade Committee's report with reference to the recent fire, which stated among other matters that the committee were satisfied from the evidence that the telephonic communication was out of order, but that had the telephone been in order, the evidence proved there was no person in charge of the police station at Portswood to answer the telephone after 12 o'clock at night. Ultimately the committee's report was adopted.

Moss Side (Manchester).—At the meeting of the Urban District Council held recently, the clerk reported that a letter had been received from the Gas and Electric Lighting Committee of the Manchester Corporation, suggesting a conference of the Stretford, Moss Side, Withington, and Levenshulme Councils respecting the extension of the Corporation electric current in these districts. A deputation was appointed to attend the conference on behalf of the Council. It was also reported that a deputation had waited upon the General Purposes Committee on behalf of the South Manchester Electric Supply, Limited Mr. Clirehugh, on behalf of the deputation, expressed an opinion that the cost of the first instalment of cabling in the district would be about £5,000. The company would offer the Council a wholesale supply of current at a charge of 4d. per unit, leaving the Council to supply customers and collect accounts. The usual charge by the company was 7d. per unit. The Council might at any time acquire the undertaking in their district by giving six months' notice, subject to certain other conditions. The district would comprise Moss Side, Stretford, Withington, Levenshulme, and Heaton Norris, with a central supply station near the crematorium at Withington. It was further reported that the General Purposes Committee had received a deputation from a syndicate for supplying electricity for lighting or for motive power. The deputation explained the proposal of the company. They suggested a scheme of tram haulage in connection with the scheme for laying suburban lines from Peel Causeway through Brooklands and Sale to Stretford, and remarked that the lines might be continued along Seymour-grove, Old Trafford, branching off at West Point to Chorlton-cum-Hardy; also to Brooks's Bar, along Raby-street and Moss-lane East, Wilmslow-road, and Dickenson-road to Longsight, with a branch at Stretford along Edge-lane to Chorlton-cum-Hardy, and so forward past the Manchester Cemetery, Burton-road, Lapwing-lane, and on through Heaton Mersey to Stockport. The deputation was informed that the Council would give early and earnest consideration to the suggestion made on behalf of the company.

Canterbury.—The Lighting Committee have reported that Mr. R. Hammond, the electrical engineer, had attended and submitted final plans and estimates, etc , of the electric lighting works and dust destructor. The committee recommended that they should be adopted, and that the engineer be authorised to advertise for tenders. The committee recommended that a sum of £1. 1s. per day be allowed as travelling expenses to the engineer for his visits to the city, and that second-class railway fare and expenses be allowed his assistant. In the Town Council Alderman Cross asked if it had been finally decided that the dust destructor be placed on the site at the Miller's Field. He thought before giving orders for tenders to be advertised for they should come to an understanding whether the Council had quite decided to have the destructor on that site, as he was under the impression the majority were against it. He should also like to suggest that first-class fare and no expenses be allowed the engineer's assistant. After a good deal of discussion an amendment was carried rejecting the dust destructor, and finally the whole question became mixed up with the sewage farm and the drainage system, so that the Town Clerk said he did not know what to do. The plans were prepared and everything got ready for the reception of tenders, and now they had done something which would prevent the tenders being asked for The plans and forms of tender had already been drawn up—one for the electric lighting station only, and the other including the destructor—and if they adhered to the resolution now passed they would have to alter the whole thing. He should be really ashamed to write to the engineer. He appealed to the Council whether the course recommended should not go on. They could afterwards accept the tenders or not as they thought fit. Ultimately, by way of getting matters in order and getting rid of conflicting resolutions, the town clerk suggested that the whole thing should be referred back to a special meeting of the Council, and, after further discussion, this course was agreed upon, it being also resolved that no minutes be taken of that day's discussion.

Morley.—The town clerk has reported to the Town Council that he has received the formal license granted by the Board of Trade under the Electric Lighting Act authorising the Corporation to undertake the supply of electric light. Alderman Stockdale moved and Councillor Craven seconded the adoption of the following report of the Electric Lighting Committee: "The committee, at a meeting on the 13th ult., had an interview with Mr. Hammond and discussed various additions and alterations which the increased experience derived from new works had rendered desirable since his first report was given three years ago. After fully considering the matter, the committee recommended (1) that the alterations and additions be approved, and that Mr. Hammond be requested to amend his original report and estimate in accordance therewith; (2) that as it is found to be impracticable to have the scheme generally available by November 1 next, the contracts be advertised in sections for the various kinds of work, as may be approved by the committee, the underground work to be advertised and let at the earliest moment; (3) that in consequence of the present condition of Queen-street, the borough surveyor be instructed at the earliest possible moment to have iron pipes fixed under all street crossings, in positions to be indicated by Mr. Hammond, to enable the paving to be proceeded with; (4) that the committee be empowered to make such temporary arrangements for augmenting the Town Hall supply as will enable pressing cases to be dealt with as they arise; (5) that Mr. Hammond's remuneration be fixed at 5 per cent. on all contracts which may be actually carried out, in addition to travelling expenses, and the quantity surveyor's fees at 2½ per cent. on such contracts, but this is not to impose any obligation on the Council to proceed with any work. The premium of £100 is to be merged in the commission. This is not to include the clerk of works." Alderman Dixon moved an amendment, which Councillor Armitage seconded, that clause number 5 be altered by providing that Mr. Hammond be not allowed travelling expenses, and that the commission to him and the quantity surveyor be limited to 5 per cent. to Mr. Hammond, and with this alteration the report was adopted.

Hammersmith.—We have received the tenth annual report of the Hammersmith Vestry. This gives a full account of the work of the Vestry, and its appearance serves as a suitable occasion for summing up the progress made towards the adoption of the electric light in that parish and the method of procedure. On April, 1895, the Electric Lighting Committee reported on the various sites available for a generating station, and recommended the Vestry to treat for the purchase of two pieces of land abutting upon Fulham Palace road. The report was approved, and the purchase was subsequently completed for £7,200. The next report is dated May 29, and is to the effect that having appointed a sub-

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committee, who have viewed the electric lighting installations at Chelsea, Ealing, St. Pancras, and Portsmouth, and carefully considered the information gained respecting the various systems in use at those and other places, the committee could not then advise the adoption of the report of Messrs. Williams and King. They recommended the Vestry to advertise for complete schemes and tenders for boilers, machinery, mains, etc., necessary to carry out the work included in the compulsory area, and when such tenders and schemes were received, the Vestry should proceed to consult one or more engineers to advise thereon. This recommendation was also approved, and the advertisements issued, the committee reporting that "we" have "drawn up the necessary particulars." The specification was, as a matter of fact, unsigned, and the name of the engineer responsible for it is unknown. Tenders came in on October 4 from all the noted firms. These were opened and referred to a sub-committee for report. This sub-committee consisted of four members and the surveyor, and they soon found the need of expert advice. In spite of the unsettled state of the scheme, tenders were then obtained for preparing the site for the buildings and for doing the excavation work. Then Mr. A. H. Preece was, in March of this year, appointed consulting engineer. He advised that of the tenders received those of Messrs. Ferranti and Co. and Messrs. Siemens Bros. were most favourable. To decide between these he advised that new specifications should be issued to these firms to include rectifiers, and finally the tender of Messrs. Ferranti and Co. was accepted. We trust that the work will now progress favourably, but think it would have been more fair to the contractors and more advantageous to the Vestry to have retained the expert to draw up the first specification. We concluded that every tender sent in had to be detailed by the contractor, and hence that no less than 11 firms had to do practically the work of a consulting engineer. We do not wonder in such a case that expert advice was needed to select the most favourable offer.

Glasgow.—A meeting of the Tramway Committee has been held to consider the remit from the Town Council asking that the committee should reconsider that portion of the minutes which had reference to the proposal to try by way of experiment the overhead electric system of traction on the detached route between Springburn and Mitchell-street. Councillor Colquhoun proposed that the matter be remitted to the sub-committee to obtain all necessary information and report. This was met by a direct negative by Councillor Oatts. After a stormy discussion, a division was taken, when seven voted for the motion and seven for the amendment. The chairman declined to give a casting vote. The result of this will be that the question of the electric motors will come up again before the Corporation. The Corporation Committee on Gas Supply and Electric Lighting have issued their annual report. The report, dealing with the fourth year of the electric lighting department, stated that the gross revenue for the past year amounted to £25,862 8s. 6d. and the gross expenditure to £11,589. 19s., and that, after accounting for depreciation, interest on loans, and additions to the sinking fund, their remained a surplus on the year's operations of £2,380. 19s. In view of that favourable balance the committee recommended a reduction in the price of current on a scale which necessitated that a new method of charging should take effect as from and after June 1 last. That new method, it was anticipated, would increase the popularity and use of the electric light. Indicators would be placed in customers' premises to ascertain the greatest quantity of electricity taken at any one time during the year, which quantity would be called the "maximum demand." To customers who used in the year the maximum demand for 365 hours only, being an average of one hour per day, or any lesser quantity, the price charged would be at the present rate 6d. per Board of Trade unit, but for all electric energy used over that quantity the charge would be at the rate of 4d. per Board of Trade unit. The committee also recommended the discontinuance of the charge for meter hire, and that the price charged for each lamp should be reduced from £26 to £20 per annum. The number of consumers at May 31 last was 855, being an increase of 269 over the number at the same date in the previous year. The quantity of electricity sold during the past year to private consumers, irrespective of public lighting was 866,606 Board of Trade units, being an increase of 24·11 per cent. The twenty-seventh report of the gas department showed a gross revenue of £605,794. 1s. 10d., with a surplus on the year's operations of £502. 12s. 9d. The committee recommended that the price of gas be reduced from 2s. 4d. to 2s. 2d. per 1,000 cubic feet. The quantity of gas sold or accounted for during the past year was 4,259,169,000 cubic feet, being an increase as compared with the previous year of 5·71 per cent.

Ipswich.—We briefly noted last week that the Town Council had postponed the consideration of the electric lighting scheme until October. The report of the Electric Lighting Committee was that, in accordance with the directions given by the Council, they took steps to oppose the grant to the County of London and Brush Provincial Electric Lighting Company, Limited, of a provisional order empowering them to supply electricity within the borough of Ipswich, and the result was that on March 16 last the Board of Trade wrote stating that they did not propose to proceed with the application. No expenses were incurred by the committee in the opposition, the matter being carried through by the town clerk. As the time had gone by for any outsider to give notice for the next session of Parliament, no provisional order could now be obtained by any private individual or company before July, 1898. The Council further empowered the committee "to consult Prof. Kennedy upon the question of electric lighting at a cost not exceeding £50." Having ascertained that his fee would be within the limit fixed by the Council, the committee requested Prof. Kennedy to give them details of the smaller scheme which he had previously mentioned, and in reply he forwarded a report. Having regard to the views already expressed by the Council on more than one occasion as to the necessity for including in the area for immediate supply streets which were not embraced in this report, it was considered desirable to obtain Prof. Kennedy's estimate of the cost of providing means for supplying electricity in four different areas (exclusive of public street lighting). Lists of the streets in these areas are given, but they would not be intelligible without a map of the town. The areas proposed vary from practically the two main streets to nearly all the important streets on the town side of the river and the lighting of the docks. Prof. Kennedy was also asked to ascertain what would be the total additional capital outlay required to provide for lighting the public streets in each of these areas by electricity. The committee substantially recommended a medium area, with the addition of the docks and quays. The estimate for this is: capital outlay required to provide means for supplying electricity, £25,000; for public street-lighting, extra, £2,500; professional fees and commission, say, £1,500; cost of provisional order, etc., say, £350; sundries, £350; total, £30,200. For the largest area the total is £41,900, while Prof. Kennedy's report as to the smallest scheme stated that the scheme was one which he mentioned in an answer to a question as to what amount of electric lighting could be carried out in Ipswich for about £18,000. The site for the station ought to be that called Canham's Marsh, at the back of the cattle lairs. About 32 arc lamps would be required to light the central part of the town and Princes-street as far as the railway station, and they were included. As to dust destructor, Canham's Marsh would suit admirably, and he had no doubt that, at any rate, the waste heat from the destructor could generate enough steam to keep the station going at times of light load, and consequently save a considerable amount of fuel. If a destructor were to be put down it would be as well that the matter should be decided at the same time as electric lighting. As to arc lighting for streets, Prof Kennedy's memorandum of June 1 stated that it would not be necessary to provide any special plant in the station. The additional cost of the arc lamps, therefore, was limited to that of the lamps and posts, with switches etc., amounting to about £32 per lamp. For the streets mentioned in the smallest (£18,000) scheme, 28 lamps would be required, costing £900; for the recommended scheme, 80 lamps, cost £2,500; for the largest scheme, 180 lamps, cost £5,700. In the smallest area there are a number of establishments already wired and fitted. These are at present either without current or supply themselves with gas-engines.

Ashton-under-Lyne.—Mr. S. V. Clirehugh, electrical engineer, in his first report to the Works Sub-committee of the Town Council, recommended a low-tension continuous current system, having regard to the fact that the area to be supplied is compact and thickly populated. The site of the generating station depended on the question as to whether refuse destructors are to be included in the scheme—*i.e.*, if destructors are used it is essential that the site at the town's yard be utilised. If, on the other hand, they are not, then the site by the Technical School might be used if there were very strong local reasons in its favour; but Mr. Clirehugh recommends the site at the town's yard for the following reasons: There is more land belonging to the Corporation than is ever likely to be required for the town's yard; there is a railway siding on the ground; there is a probability of sinking a well which would yield sufficient water for condensing purposes, or, if this is not possible on investigation, there is sufficient land to erect an evaporative condenser; and although not so central as the Technical School, the site may be considered sufficiently central for the purpose. Great controversy had arisen over the use of refuse destructors in connection with steam raising, certain experts maintaining that the conditions for a perfect destructor are directly opposed to the conditions required for obtaining the maximum calorific value of the burning refuse. More recent experiments had, however, shown that such was not the case, and the general consensus of opinion is that in the North of England 1lb. of refuse had a calorific value of about one-fourth to one-fifth of that of good coal. These figures are confirmed by the fact that many of the leading firms were willing to erect destructors under the most stringent guarantees as to their efficiency. From information supplied by the borough surveyor there was about 14,000 tons of refuse to dispose of annually, which was capable of maintaining 280 h p. continuously. The difficulty of utilising refuse to generate steam for electric lighting purposes only was due to the fact that electric lighting stations had a very bad load factor—that is to say, the works are only fully occupied for about two hours out of the 24, while refuse is continually coming in, and cannot conveniently be stored, or, if it could, provision could not be economically made for burning so large a quantity in so short a time. This brought forward the question of the advisibility of the Corporation supplying the tramway company with power. Mr. Clirehugh continued: "I have seen Mr. Sellon, the engineer to the company, on this subject, and he expresses willingness to enter into negotiations with the Corporation. In my opinion, provided the tramway company were willing to pay a reasonable sum per unit of power, it would be an excellent customer for the Corporation. They would probably require about 150 h.p. continuously, which would enable the refuse to be consumed as fast as it was brought in. The system is one of great advantage, as it enables the machinery to work fully loaded for a greater portion of 24 hours. Two well-known instances where the lighting authorities supply the traction company with power are at Hamburg and at Havre, and the Corporation of Swansea are also carrying out a similar scheme. When the points which I have raised in this report are settled, I shall be in a position to prepare

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a scheme for the town and submit to you details of capital outlay, etc., required." After consideration of the report, the committee resolved that a continuous-current system should be adopted; that the town's yard site be adopted for the works; and that refuse destructors be employed in connection with the scheme; but that further consideration of the matter be deferred until the issue of the surveyor's report on destructors and the sub-committee's visits to inspect them. It was also resolved that the Corporation should supply the tramway company with power, and that the town clerk should write to the company informing them that the committee approved of their suggestion, and requesting them to consult with Mr. Clirehugh on matters connected therewith. The Market and Lighting Committee were requested to consider and decide as to which streets it is desirable to lay electric light mains in for street-lighting purposes. On all this coming up in the Town Council the minutes were confirmed. The Market and Lighting Committee had resolved that the Electric Lighting Committee be requested to lay mains for street-lighting purposes in a long list of streets, and this recommendation was passed on the motion of the Mayor, seconded by Councillor Chadwick.

PROVISIONAL PATENTS, 1896.

AUGUST 10.

17643. **A pocket electric lamp for use by surgeons and the like.** Robert Anderson Smith and Frederick George Bowley Green, 154, St. Vincent-street, Glasgow. (Complete specification.)

17657. **Improvements in electrical indicators.** Hugo Korten, 1, Park-terrace, Archway-road, Highgate London.

17659. **Receptacle for electric and other wires.** Edward Fenn Jones, 13 Eastcheap, London.

17661. **Improvements in electric pendulum indicators.** Frederick Jones, 7, Berber-road, Wakehurst-road, Wandsworth Common, London.

17666. **Improvements in automatic maximum speed governors for electrically propelled vehicles.** Horace Field Parshall, 70, Chancery-lane, London.

17671. **An improved method for obtaining porous metals by electrolysis.** Ludwig Hoepfner, 45, Southampton-buildings, Chancery-lane, London.

17701. **Improvements in electrical switching apparatus.** Henry Edmunds, 47, Lincoln's-inn fields, London.

AUGUST 11.

17818. **Improvements in dynamo-electric machines.** The British Thomson-Houston Company, Limited, 70, Chancery-lane, London. (David P. Thomson and Albert H. Armstrong, United States.) (Complete specification.)

AUGUST 12

17832. **Improved arrangement for lowering the globes of arc and other lamps.** Haldane Gwilt Cotsworth, 125 Merton-road, South Wimbledon, Surrey.

17846. **Improvements in telephone switchboard plugs.** The Telegraph Manufacturing Company, Limited, and James Taylor, Helsby, near Warrington.

17879. **Improvements relating to electric batteries.** Vincent Marie Cornely and Louis Charles Henry Dautel, 6, Breams-buildings, Chancery-lane, London.

17890. **Improvements in batteries for the electric lamps of cycles.** Ernest Tilmann and Charles King Lexon, 22, Southampton buildings, Chancery-lane, London.

17906. **Improvements in crossings of electric conductors for electric railways and tramways.** Albion Thomas Snell, Charles Edward Grove, and Arnold Frank Hills, 47, Lincoln's-inn-fields, London.

AUGUST 13

17915. **Improvements in means for the manipulation of electric lamps.** Arthur James Ireland and Charles William Godson Little, 20, Lawn-crescent Kew Gardens, London.

17951. **Improvements in continuous-current generator dynamos or motor dynamos.** Albert de Puydt and Maximilien Poncin, 60, Queen Victoria-street, London.

AUGUST 14.

18005. **Improvements in electromagnetic gearing.** David Cook, 30, Lancaster-park, Richmond, Surrey.

18046. **Improvements in electric accumulators or secondary batteries.** Mich'l M Brophy and Joseph Devonport Finney Andrews, 45, Fulham Park-gardens, London.

18053. **Improved means or appliances for supporting revolving shafts, and the arrangement of rotary motors and dynamos in connection therewith.** Reginald Wood, 28, Southampton-buildings, Chancery-lane, London.

18076. **Improvements in or relating to direct-current dynamos and electromotors.** Francis Henry Davies and Charles Orme Bastian, 31, Southampton-buildings, Chancery-lane, London.

18080. **Improvements relating to telegraphs.** Albert Edward Collyer, 55, Chancery-lane, London.

AUGUST 15.

18103. **Improvements in electricity and other supply meters.** Matthew McAuley Gillespie and William Richard Wynne, 20, Craven-road, Harlesden, London.

18107. **Improvements in and relating to electric lights and installations.** Jabez Jackson, Linton House, Starley-road, Coventry.

18118. **Improvements in electric lamps for velocipedes and vehicles and in the method of generating and storing electrical energy therefor.** Albert Montague Armstrong, 59, Derby-road, Croydon.

18134. **Improvements in and connected with electric conductors and in means for making connections therewith, the invention being particularly applicable for theatres and the like.** George Heys Jones, 55, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1895.

13702. **Apparatus for regulating or measuring electric currents.** Pieper.

14134. **Rapid telegraphic transmission on cable lines.** Langdon-Davies.

16042. **Compound electrical testing switch.** Norman.

16494. **Supports for overhead electric conductors.** Lake (Goodwin).

17526. **Electrical transformers.** Berry.

17655. **Secondary batteries.** Drake and Gorham.

17656. **Spring contact switches.** Drake and Gorham.

22505. **Active material for electric accumulators.** Dannert, Windolff, and Zacharias.

1896.

3690. **Electromagnetic induction system of supplying power to electrically propelled vehicles** Shuttleworth.

12345. **Automatic apparatus for the working of telephone stations.** Naglo.

13263. **Friction grip for sliding rods applicable to holders of electric lamps, carbons, and the like.** Preece.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5¾-6¼
Brush Company, Ordinary	3	1-1¼
——— Non. Cum., 6 per cent. Pref.	2	1⅜-1⅝
——— 4½ per cent. Debenture Stock	100	112-115
Central London Railway, Ordinary	10	10½-11
———	2	2¼-2½
Charing Cross and Strand	5	8¾ 9¼ xd
Chelsea Electricity Company	5	7¾-8¼
——— 4½ per cent. Debentures	100	114-116
City of London, Ordinary	10	16-17
——— 6 per cent. Cumulative Pref.	10	17½-18½
——— 5 per cent. Debenture Stock	100	133-137
City and South London Railway, Consolidated Ordinary	100	47-49
——— 4 per cent. Debenture Stock	100	136-128
——— 5 per cent. Pref. Shares	10	14½-15
County of London and Brush Provincial Co., Ordinary	10	8-9
——— 6 per cent. Cum. Pref.	10	13½ 14
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
Edison and Swan United Ordinary	3	1¾-2¼ xd
——— 4½ per cent. Debentures	100	103-106
Electric Construction, Limited	2	1½-1¾
——— 7 per cent. Cumulative Pref.	2	2¾ 3¼
Elmore's Copper Depositing	2	¾-1
Elmore's Wire Company	2	⅜-⅝
W. T. Henley's Telegraph Works, Ordinary	10	18-19
——— 7 per cent. Preference	10	18½-19½
——— 4½ per cent. Debentures	100	109-114
House-to-House Company, Ordinary	5	4 4½
——— 7 per cent. Preference	5	8-8½
India Rubber and Gutta Percha Works	10	22-23
——— 4½ per cent. Debentures	100	107-110
Kensington and Knightsbridge Ordinary	5	9½-10
——— 6 per cent. Pref.	5	7¾ 8¼
Liverpool Electric Supply, Ordinary	5	8-8¼
Liverpool Overhead Railway	10	13¾-13⅞
——— 5 per cent. Pref.	10	17⅛-17⅜
——— 4 per cent. Mortgage Debentures of £100	100	112½-114½
London Electric Supply	5	⅞-1⅛
Metropolitan Electric Supply	10	13¼-13¾
——— 4½ per cent. First Mortgage Debenture Stock	100	120-123
National Telephone, Ordinary	5	7⅝ 7⅞ xd
——— 6 per cent. Cum. First Pref.	10	17-19
——— 6 per cent. Cum. Second Pref.	10	17-18
——— 5 per cent. Non. Cum. Third Pref.	5	6¾-7
——— 3½ per cent. Deb. Stock	100	107-110
Notting Hill Company	10	11-12
Oriental, Limited, £1 shares	1	1½-2
——— £5 Shares	5	8¼-8¾
——— £4½ shares	4½	7½-7¾
Oriental Telephone and Electric Company	1	¾-⅞
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	105-107
Southampton Electric Company	5	4¾ 5¼
St. James's and Pall Mall, Ordinary	5	12½-13½
——— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	39-42
——— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary		8-8½
Westminster Electric Supply, Ordinary	5	11-12
Yorkshire House-to-House	5	7⅝-7⅞

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NOTES.

Motorcars in Paris.—By a decision of the Prefect of the Seine, horseless carriages have just been admitted to all the rights and privileges for public service of the ordinary *fiacre*. The step is a wise one, and it will be interesting to watch the progress of the competition. If some such by-law were made in a few large towns in England the industry might soon become a great one, but all the while it is confined to Crystal Palace exhibitions it is not calculated to make the fortunes of many people.

Motorcar.—The *Morning* has an interesting note to the effect that in St. Margaret's Church, Westminster, there is a memorial window to Sir Goldsworthy Gurney, the inventor of the limelight, and also the inventor and conductor of the first locomotive carriage along ordinary roads. Sir Goldsworthy took a steam locomotive carriage from London to Bath, having for passengers the first Duke of Wellington and Sir Francis Burdett. In the vestry of St. Margaret's there is an extremely rare and interesting engraving of this first road locomotive.

Argon in Combination.—The Paris correspondent of one of the daily papers has just heard of an interesting discovery made by Prof. Villard. Ever since the discovery of argon, chemists have tried with indifferent success to make combinations between this gas and its sister elements. Prof. Villard, of the Ecole Normale, has at length prevailed upon this element to combine with water. He found that no pressure short of 200 atmospheres would coerce argon into combination with water. The compound is colourless, and crystallises very prettily when kept cool.

A Russian Invasion.—Journalists in St. Petersburg have been busy chronicling what they describe as a series of remarkable telephonic experiments which have recently been made in Moscow, in the course of which messages, airs, and songs were conveyed by means of M. Keldushoffsky's new telephone between Moscow and Rostoff on the Don. The distance between these two towns is 1,340 versts, or 900 English miles, whilst the wire used on this occasion was over 1,800 miles long. It is stated by the representative of the Moscow *Gazette* who witnessed the experiments, that the inventor of this new telephone soon intends visiting England in order to see whether telephonic messages cannot be conveyed from England to America by means of the Transatlantic cable.

The Eclipse of the Sun.—The Russian Astronomical Expedition which was sent to the North of Finland to observe the solar eclipse, telegraphs from Tornea that owing to the magnificent weather which prevailed at the time, 10 good photographs of the corona were obtained by means of three different apparatus. The Hydrographical Department has received a telegram from General Baron Maidelicheff, of the Saghalien astronomical expedition. The message, which was despatched from Cape Notoro, the south-western extremity of Saghalien, states that the observation of the eclipse was fairly successful and that, although the sky was cloudy, two photographs of the corona were obtained. Some magnetic variations were noticed during the eclipse. It would be interesting to know whether the observers attributed the magnetic variations to thermo-electric effects.

A Curious Lamp Deformation.—A curious deformation of a lamp occurred some time ago in a German theatre. The lamp in question was a 20-c.p. 110-volt incandescent, and was fixed in a horizontal position to a wall in the flies. A "super" was, however, instructed to cut out this lamp, and having not knowledge of the technicalities of electric lighting failed at first to do so. He finally dimmed the offending lamp by wrapping round it a towel, on which the remains of "make up" and make-up grease were well in evidence. The result was that the heat of the lamp so softened the glass of the bulb that from a horizontal it fell into a semi-vertical position, and the glass coming in contact with the filament broke the latter. The cloth was badly scorched, but did not ignite. The lamp did not break. The illustration accompanying this information in our New York contemporary shows the effect of the vacuum on the softened glass.

Stirring up an Electric Battery.—An amusing case over the damage done to an electric battery was tried recently at Sunderland, and shows the hardship automatic penny collectors have to put up with. Evidence showed that the "electric battery" was in good order when supplied to the defendant, an innkeeper; in fact, several tried it and all were shocked. The machine afterwards was supposed to have acquired the dishonest practice of absorbing pennies without shocking the givers. The landlord then told his customers to hit it with something hard. A soda-water bottle seems to have given satisfactory results for a time, but one night the machine was assaulted with a poker to the extent of £5. 8s. 6d. This, and the language used, was too much for the works, and the owner of the unlucky machine finally obtained judgment accordingly. We suppose that the theory of hitting it with something hard originated from a knowledge of the ways of the wet gas-meter.

The Falls of Foyers.—The proverb, "Where the carcase is there will the eagles be gathered," can be renovated to read, "Where the power is cheap there will be found the manufacturers." At Niagara a number of new factories and a new town is springing up in consequence of the power available for harnessing in the large falls there. Again, at Foyers the power available caused the British Aluminium Company to establish works there to the great advantage of the inhabitants. We now hear that the Acetylene Illuminating Company have arranged to share the advantages of the site and of the water power rendered available by the enterprise of the British Aluminium Company. By the arrangements entered into between the two companies, works will be erected which will require several thousand horse-power for the manufacture of calcium carbide. Until these works are complete power will be taken from the dynamos of the British Aluminium Company, as described in our issue of May 8. A carbide plant is now being erected, and it is expected it will be in full swing during October. We are glad to chronicle the fact that this valuable product is to be made in Great Britain.

Locomotives on Highways.—We regret to note that the impetuosity of an electrical engineer at Westminster to distinguish himself as the owner of self-propelled vehicle has led the gentleman in question into trouble. The police station charge stated that the motorcar was driven twice round Parliament-square at a pace of four miles an hour. Defendant, when spoken to, said he had the permission of Sir E. Bradford to try the car on the public road. It seems that this was not the first offence, but after the passing of the new Act the defendant could not refrain from furious driving. In the interest of the public such high speeds are thought to be dangerous. The gravity of the case was evidently derived from the fact that the same thing had occurred before, and that although the Commissioner of Police had given permission for the cars to proceed along the roadway on specific occasions to various exhibitions, he would not countenance a general use of the car in the streets. The magistrate said that people must learn that they could not drive motorcars in the street

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except under stringent regulation. We feel that the electrical engineer in question was rather premature in the use of his car, and trust that his experience will save others from falling into the same error before the Act comes into force.

The Chemists' Exhibition.—The second annual Chemists' Exhibition, held this week, has undoubtedly proved a success. The stallholders numbered 124, twice as many as last year, and it is even stated that many applications for stall room from members of the various trades interested had to be refused. The appearance of the show was that of practical utility rather than sensational display. Such things as mineral waters, and the appliances used in its manufacture, formed a striking contrast to an exhibition of the Röntgen rays, but it was a healthy sign to see that all branches of investigation covered by that useful section of civilisation, the chemists, could be brought together in one collection for scrutiny and comparison. All the well-known firms were represented at this exhibition in the National Skating Rink, Argyle-street, W. Among the other attractions was the Hungarian Ladies' Orchestra, of which Mdlle. Kati Erl is the conductress, whose finished performances added much to the enjoyment of the visitors.

Is Aluminium Poisonous ? — A correspondent describes the following experiments in the columns of the *Morning Post*: Recently two healthy and robust physicians, aged 26 and 35 years, were selected by the Imperial German Health Bureau to undergo an interesting experiment. These two gentlemen, in order to test the non-poisonous properties of aluminium, volunteered every morning for one month to swallow 15 grains of aluminium tartrate with their lunch. At the end of the trial neither of them had lost flesh nor appetite, or experienced the slightest discomfort during the entire period of their metallic lunch. It is found that the metal is not adapted to contain for a lengthened period brandy, whisky, or wine. After a time these turn turbid, and, although perfectly harmless, are not inviting even to the thirsty traveller, who, however, need not fear filling his flask for a two or three days' journey. The correspondent has used cast-aluminium cooking utensils for over 12 months, and they have given both the cook and the consumer every satisfaction, without any fear of poisoning as when using copper utensils. Dental plates are now made in aluminium, which, besides being only a fraction of the weight of gold plates, possess the additional advantage of producing no disagreeable taste in the mouth.

The Institution of Junior Engineers.—The summer meeting of this institution has just been held in Scotland. The members have visited several of the large towns, and have met with a very hospitable and cordial reception. Among the towns visited was the royal burgh of Dumbarton, where they were officially received by the provost, magistrates, and Town Council, and visited some of the public works in the town. The company, which numbered about 50, travelled to the town by a train arriving shortly after 10 o'clock, and were there received by Mr. Archibald Denny, president of the institution, and a partner in the firms of Messrs. Denny and Bros., shipbuilders, and Messrs. Denny and Co., engineers. From the station they proceeded to the Lesser Burgh Hall, where they were met by Provost Garvie, Bailies Barlas, Henderson, and Young, the other members of the Town Council, and a number of other gentlemen. Leaving the hall the party, accommodated in wagonettes, drove round the town by way of Levengrove Park and the Castle, returning to the Leven Shipyard, where, on the invitation of Messrs. Denny and Bros., luncheon was served in the model hall. Votes of thanks to the Town Council and the firm of Messrs. Denny and Bros. were then awarded. The party were then shown through the Leven Shipyard, and subsequently the forge and the engine works were visited.

Electrocution.—The following editorial from the *Electrical World* of New York is worthy of full notice, as it is not often that sentiment is allowed to obstruct business in America. The editor says: "It will be remembered that the last Ohio Legislature passed a measure which went into effect on July 1 legalising electrical executions in that State. The making of a law is one thing and fulfilling its requirements are quite another, as the Ohio penitentiary officials are discovering to their dismay. They are experiencing unforeseen difficulties in securing an alternator to carry out their deadly work. That the various manufacturers of the necessary electrical machinery have no desire to sell their apparatus for such purposes is evidenced by the fact that no response was received to the invitation for bids for the death-dealing outfit. When electrocutions became lawful in New York State the penal authorities encountered the same difficulties, so that it was only by resorting to considerable strategy that an alternator was secured. It is not unlikely that the Ohio officials will be compelled to seek the same means to attain their end. The objection of manufacturers to selling electrical machinery for the purpose of killing human beings is not one of sentiment alone. It is no recommendation to apparatus of any kind to have it used, even by the constituted authorities, for the purpose of taking human life."

Assistance to British Trade Abroad.—Since the present Government came into power they have given very attentive consideration to the question of British commercial interests abroad. In the Consular and Commercial Departments of the Foreign Office the following suggestions have the approval of the Secretary of State. Two new commercial attachés will be appointed, one to Germany, the Netherlands, and Scandinavia, to reside at Berlin, the other for Spain and Portugal, to reside at Madrid. The commercial attachéship at Paris has been reorganised, and its district will in future cover France, Belgium, and Switzerland. The commercial attachéship in Russia and Western Asia has also been reconstituted, and the south-eastern parts of Europe have been included, while Asia has been excluded from its sphere. A consul for Lombardy has been appointed to reside at Milan with a special view to the collection of commercial information. The consular staff in Siam will be increased by two new appointments, but the exact areas of the new consuls' jurisdictions are not yet fixed. Other important appointments are under consideration also. As a result of communications which have passed between the Foreign Office and the Association of Chambers of Commerce, supplementary instructions are in course of being issued to her Majesty's consuls regarding assistance to trade, the collection of samples, and information of a commercial nature. More complete arrangements have recently been made for the immediate publication in the Press of invitations for tenders for work abroad. We trust that the effect of these steps will be to increase our exports of electrical goods.

The Everlasting Rontgen Ray.—The correspondent of the *Standard* sends the following information from Toulon, culled from the columns of the *Petit Parisien*, to the effect "that the Active Squadron of the Mediterranean has just effected experiments with a new method of signalling. The squadron left Marseilles on 20th inst., at five o'clock in the evening, leaving behind it the torpedo-catcher 'Faucon,' which weighed anchor the same evening at eight o'clock. The 'Faucon' was to find the squadron during the night, though all the vessels were sailing with-

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out lights. The 'Faucon,' by the aid of what has been named by the common sailors the *feu de ratière*, succeeded in discovering the squadron by one o'clock in the morning. This *feu de ratière* is a very small apparatus, which, it is said, throws electric rays which cannot be perceived either on the right or the left, but simply in front of the apparatus. It produces no reflection, and the light can, it is affirmed, only be seen under special conditions known to none but those working it. This light will, it is said, also serve for signalling at night when it may be desirable to avoid an enemy understanding signals made by rockets. It is claimed for it also that it will serve to guard a squadron steaming in file with extinguished lights." We are informed "that no foreign navy possesses this apparatus invented by a French naval officer, and it can be easily understood that our squadrons should guard the secret jealously. Only the commander of the ship and a non-commissioned officer working it, who have taken an oath not to divulge the secret, are at the present moment acquainted with it. The apparatus is carefully kept in a cabin, of which the commander of the 'Faucon' alone has the key." How a non-reflecting light can assist the search party we fail to see.

Paris and Glasgow.—*Cosmos*, which rejoices in a headpiece truly astounding in its *naïveté*, is one of our contemporaries whose function is the dissemination among the inhabitants of France of popular science—always subject to the strict limitations of what is considered good for them. Apparently the molecular theory on which is the basis of modern chemistry, is one of the things which is not good for them. It is thought to lead to "anarchism" and views on other subjects which we do not treat of in these columns. Consequently, when Mr. de Fonvielle, of *Cosmos*, made the discovery that Lord Kelvin had declared that theory was a feeble one, he was much pleased, and wrote to congratulate "Sa Seigneurie." Apparently he would not presume to speak of a man who had made such a discovery merely as Monsieur le Baron. The letter, which is published in full in *Cosmos*, is a very curious one. Nothing, it seems, that Lord Kelvin has ever done can exceed in importance his pronouncement on the subject. Lord Kelvin replied in a dignified letter, which, when translated, makes exceedingly good French. He had been slightly misunderstood—that is all—and was alluding only to the weakness of his efforts in the work of explaining the cause of things; in fact, he had never been more certain of the absolute truth of the kinetic theory of gas than he was at that moment. There are those, we know, who do good by stealth and blush to find it fame, but Lord Kelvin must have been slightly astonished when he discovered this particular contribution of his own to the progress of science, and the more so, as Mr. de Fonvielle is apparently by no means still convinced that "Sa Seigneurie" of Kelvin does not really think as he was at first believed by our contemporary to do on the subject.

An Automatic Electric Lift.—A communication to the *Electrical World* by Mr. Theodore Water, on electricity in private houses, contains a description of an electric lift which is automatic. The pressure of a single push button on each landing is all that is necessary to bring the car to that particular landing. The car having arrived at that landing stops automatically. The door of the shaft is then unlocked, and may then be opened and the car entered. When the door is open the whole system is electrically beyond control, and no part of the machinery can possibly move until the door has been closed. For instance, if someone after using the elevator should carelessly leave the door partly open after him, it would be impossible to call the car to any other floor, it first being necessary to shut that door. This precludes the possibility of an accident happening through a simultaneous attempt of two persons to operate the elevator from different floors. There is but a single push button on each floor which performs the function of calling the car in either direction. Within the car three buttons are used. These are labelled "up," "down," and "stop." A simple electromagnetic gear in the cellar regulates the automatic movement of the car. The whole system is good for country houses provided the gear is reliable. The author proceeds afterwards to describe the electric indicating gear fixed to each bedroom of this model house. A long plumb-bob shaped frame containing four pushes is hung at the head of each bed. The pushes are labelled "asleep," "awake," "closed," "locked," and work indicators outside the door. This is for the use of servants, we are informed. The mistress of the house can in this way let the servants know whether she is asleep and if the door is shut. Provided the accuracy of the first signal can be depended on, the apparatus should command a large sale. We are told that the last two pushes automatically close and lock the door.

The British Association.—The arrangements for the sixty-sixth annual meeting of the British Association for the Advancement of Science, which opens at Liverpool on Wednesday, September 16, have now been almost completed by the local committee, of which the Lord Mayor (the Earl of Derby) is the chairman. Many foreign men of science have notified their intention to be present, and an invitation has been sent to Dr. Nansen, who it is expected will be able to attend and give an interesting account of his recent exploits in search of the North Pole. On the evening of the opening day Sir Joseph Lister, Bart., will deliver his presidential address in the Philharmonic Hall. The sectional meetings will commence on the following day, and these will be continued until Wednesday, September 23, when the concluding general meeting will be held in St. George's Hall. The list of sectional presidents includes the names of Prof. J. J. Thomson, Dr. Ludwig Mond, Mr. J. E. Marr, Prof. E. B. Poulton, Major L. Darwin, the Right Hon. Leonard Courtney, M.P., Sir Douglas Fox, Mr. Arthur J. Evans, Dr. W. H. Gaskell, and Dr. D. H. Scott. The public lecturers of the week are to be Dr. Francis Elgar on "Safety on Ships," Prof. Flinders Petrie on "Man before Writing," and Prof. J. A. Fleming on "The Earth a Great Magnet." Excursions are to be made to Chester, the Manchester Ship Canal, the saltworks at Northwich, the Rivington and Vyrnwy Waterworks, and the London and North-Western Railway Company's works at Crewe. In addition to the invitation of the Earl of Derby to visit Knowsley, invitations have been extended to the association by the Duke of Westminster and Mr. Gladstone to visit Eaton Hall and Hawarden. One or more marine dredging expeditions will be organised. The larger excursions will run to the Lake District and the Isle of Man, the latter to last over five days; and Liverpool itself, of course, has much that is of interest to show, and which will be new to the association, for 26 years have elapsed since its last visit to this populous seaport.

The Insurance of Electrical Plants.—Mr. R. H. Pierce read a paper on this subject before the North-Western Association in America, and he is to be congratulated on the grip he has taken of the subject. We in England have complained of the high rates, but are not so ready as Mr. Pierce to acknowledge the reasons for these rates. The author justly puts the loss of public confidence due to interruptions at a higher value than the actual loss of machinery in case of fire. He adds that, "As a good share of the existing stations need to be rebuilt in order to

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have a decent earning capacity, the loss of plant may in many cases be considered less of a hardship than the losses through interruptions of the service." The author considers that the question of insurance can be met in three ways : (1) By insuring in responsible and reliable insurance companies. (2) By the formation of a mutual company by central-station owners. (3) By securing the maximum safety through the use of proper construction, care, and fire protection, and taking the chances of a fire loss. As a general proposition, the only reasonable course is the first one indicated—*i.e.*, the insuring in responsible and reliable companies. The plan of forming a central-station owner's mutual has been "weighed in the balance and found wanting." Theoretically, it may be possible to form such a mutual company, but it would be an additional burden to the central-station business, which, I take it, has trouble and problems enough to face already. If fire insurance is a legitimate business—and it appears to be as legitimate a business as electric lighting—then we may as well assume that the insurance people know their business, and that the competition between insurance companies will produce as low a rate as could, with equal protection, be given by a mutual company. The third method mentioned, of securing maximum safety and then taking the chances, may be the best in some, but only in very special cases. If the central-station plant is so designed, installed, and operated as to reduce the fire hazard to a minimum, insurance companies will ask a minimum rate of insurance, which in most cases will be so small as to be no burden to the owners. Discarding, then, the two plans just mentioned, we are brought to the first plan of insurance in reliable companies. Accepting this as our line of action, the problem now is to so instal and operate our plants that the hazard is reduced to a minimum, or at least to a point where further improvements would increase the cost out of proportion to the additional safety secured. Mr. Pierce proceeds to detail the present regulations of the National Board of Fire Underwriters, and to support the policy of increasing the premiums where their requirements are not fulfilled.

Rectified Current for Motors.—Mr. J. B. Hall communicates to the *Canadian Engineer* some particulars of an installation at Wentworth, Ohio, erected some three years ago. The village was lighted by alternating current, and a direct-current motor was installed in a newspaper office. The method of driving this motor from the alternating-current mains was as follows : The primary alternating current leads at 2,000 volts and 133 cycles were connected to the primaries of two transformers in parallel. The secondaries of the transformers were connected in series giving 200 volts. A synchronous motor was, however, connected to the common terminal of the two secondaries so as to get 100 volts at its terminals. The transformers were each 75 lights capacity of a standard make. The synchronous motor was of the earliest Tesla type, and had been used before to drive a small fan; this was removed, and in its place was put a commutator, which consisted of eight segments, fastened to a fibre back with air insulation between; the brushes were of carbon, and the combination was very effective in minimising the evil from the small spark that necessarily occurred. With mica between the segments, both the brushes and the commutator were burned, but without mica the brushes alone were disintegrated. The connections past the rectifying commutator were the same as is used in direct-current installation for a shunt motor. The method of working was to start the synchronous motor, and when it got up to speed to close main switch. This excited the field coils, and the circuit of armature was then made through a rheostat. The motor was a five-kilowatt undertype, with a tested commercial efficiency of 83 per cent. To find the efficiency of the combination, a five-kilowatt dynamo of 83 per cent. efficiency was directly coupled to the motor, and the current generated from it was passed into a water resistance. Measurements of that circuit were made by a Weston portable volt and ammeter and Edison chemical meter. The alternating circuit was measured by a Thomson wattmeter, and by a Westinghouse (Shallenberger) alternating-current meter. The test was of four hours' duration, and the following results were noted: The synchronous motor required about 150 watts. The Thomson wattmeter registered 30,964 watt-hours; the Westinghouse meter, 31,236 watt-hours; making an average of 31,100 watt-hours. The ammeter recorded 26·8, the voltmeter 190, each the average of quarter-hour readings; the weight of the plates in the chemical meter indicated 20,980 watt-hours. Taking the measurements as being correct, the efficiency of the combination would be about 66 per cent., or of the motor and rectifier 81 per cent. The fields of motor became a little warmer with a rectified alternating current than with a continuous current, but no loss in efficiency seemed, in the author's opinion, to be traceable to the eddy currents and hysteresis resulting therefrom.

A Reassuring Notice.—The Wire Department of Boston has issued the statement below in hopes of preventing panics in street cars: "In view of the large number of accidents that have occurred in this and other cities and towns throughout the country, due to the use of electricity as a motive power on street railways, and the panics which ensue among passengers when certain things take place that are inevitable and others that are not, the Wire Department deem it advisable to issue the following statement for the benefit of the great number of people who ride on the street cars : There are four things that are sure to occur to the electrical equipment of a street railway with a certain degree of regularity : the melting of fuse metals, burning out of motors, burning of the insulation of wires under the floors or on the roofs of cars, or breaking and melting of trolley wires. All these when they have occurred in the past have often caused a needless panic, resulting in serious injury to some of the passengers. The fuse metal would not perform its proper function if it did not melt at the proper time, and thus prevent a burning out of the motor. They often melt without any noticeable effect, but there are times when they vaporise with a vivid flash and loud report that is somewhat startling; but no injury can occur to the passengers on the car from the 'blowing' of a fuse if they will remain quietly in their places. As yet there is no means of effectually preventing the burning out of electric motors, which will occur at times on the best regulated street railroads. When this happens it will not cause the slightest injury to passengers who still remain quietly on the car until it stops. The effect produced may be somewhat startling at times to the great majority of people who ride on the cars and prompt them to seek safety in precipitate flight from seeming danger; this has often resulted in personal injury to those who do so without stopping to think of the consequences. All grades of insulated covering now used for electrical conductors are perishable, and its failure at times is to be expected. Nearly all the materials used for this purpose are inflammable. For various reasons not necessary to enumerate, the covering on the electric wires in street cars take fire and burn, but not rapidly, and, as a rule, the other portions of the car are seldom damaged. Here, again, there is no danger to the people on the car if they wait until it stops, when they will have ample time to leave it quietly. The trolley wires will and do break at

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times, but in doing so they will not injure those persons who remain in their seats. If it is necessary to leave the car, do it leisurely and quietly and avoid the broken ends of the trolley wire; it will not injure anyone who does not touch it. While it may give marked evidence of the energy it transmits when in contact with the wet ground or some other good conductor, it will not harm the passer-by who avoids it. Let all remember that this (to them) mysterious power is controllable, even though it does kick over the traces at time."

The Postmaster-General's Report.—The fifty-second annual report of the Postmaster General for the 12 months ended March 31, 1896, shows that during the year 78,839,610 telegrams of all descriptions were forwarded, showing an increase over the previous year of 7,250,546, or 10·12 per cent.; 64,563,587 of these were ordinary inland telegrams—*i.e.*, excluding foreign, Press, and free telegrams—showing an increase of 5,656,179, or 9·6 per cent. The total revenue from inland telegrams was £2,046,456, as compared with £1,880,206 for the previous year, the average revenue 7·61d. per telegram, as compared with 7·66d. The number of foreign telegrams dealt with by the Department reached 6,701,838, showing an increase of 764,123, or 12·86 per cent., as compared with the year 1894-95. This total does not represent the whole of the foreign telegraphic business of the United Kingdom. It only shows the number of foreign telegrams transmitted by the Post Office, and does not include those dealt with by the various cable companies without recourse to the postal telegraphs. 5,915,646 telegrams were transmitted at the Press rates for newspapers, clubs, etc., being an increase as compared with the previous year of 513,863, or 9·5 per cent. The average weekly number of words contained in these telegrams was about 13,650,000. Telegrams sent on behalf of the various Government departments show an increase of 22,722, or 8·33 per cent., the total for the year being 295,371, as compared with 272,649 for the previous year. The number of telegrams sent free of charge on behalf of the railway companies amounted to 1,338,818. The large increase in the number of telegrams passing over the Government cables to the Continent, and in the number of conversations on the telephone circuits between London and Paris, has rendered it necessary to consider the advisability of improving the means of communication. Arrangements have now been made for the laying of three additional cables to the Continent—two to France and one to Germany. These cables, each of which will contain four conductors, will afford a much-needed relief to the traffic. The new agreement with the National Telephone Company, embodying the arrangement arrived at after prolonged and difficult negotiations extending over nearly four years, was executed on March 25 last. In accordance with the terms of the Treasury minute, on which the negotiations are based, the agreement restricts the operations of the company to local areas, and places the trunk wires connecting those areas in the hands of the Post Office. It has not yet been found practicable to transfer the working of the whole of the wires to the Post Office, as the special arrangements for leading in the wires and fitting the necessary switchboards, etc., must necessarily occupy some time. The only wires the working of which has at present been transferred are those in the South of England. It is anticipated that the working of the whole of the remaining wires will be in the hands of the Post Office by the end of the summer. The telephonic service on the main system of trunk lines erected by the Department itself between the principal business centres of the United Kingdom to supplement those which it has now acquired from the National Telephone Company was successfully inaugurated on June 12, 1895. On July 16, 1895, the system was thrown open to the public, and there has since been a steady development of the business. During the year additional telephone circuits between London and Bristol, London and Southampton, London, Lowestoft, and Yarmouth, and London and Guildford have been completed, while further circuits between London and Birmingham, Liverpool and Manchester, Manchester and Carlisle, and Newcastle and Carlisle are in course of construction.

The Telephone in Deafness.—It is well known that in most cases of deafness the actual hearing part of the apparatus, so to say, is capable of performing its function, but the mechanism for collecting the sound waves and transmitting them to the cochlea and its appendages is defective. It is not, however, so well known that this is also the case, at least to a considerable extent, in an appreciable proportion of cases of deaf-mutism. The reasons why this should be so are exceedingly interesting, but somewhat outside our range. It must therefore be taken as a matter of fact that that percentage exists. In cases of this character, and, indeed, in all really bad cases, with the ordinary speaking-tubes and trumpets, it is essential that the mouth of the speaker should be directed into, and closely applied to, the orifice of the instrument. By this means it is well known that the intensity of the voice of the speaker is increased to an almost painful degree, but the effort of keeping the mouth applied immediately to the mouth of the tube or trumpet prevents the hearer from witnessing the movements of the lips and general expression of the speaker—a most important consideration with deaf people. By using the telephone, however, it has been found that there could be produced an intensification of the voice at least equal to the most approved form of ear-trumpet at a distance varying from 6in. to 1ft. from the mouth of the transmitter. In an article on the subject in the *Lancet*, Dr. Bertram Thornton, medical officer to the Deaf and Dumb Asylum at Margate, describes some investigations he has made on the subject, and adds, "in the experiments I have made with patients suffering from lesser degrees of deafness than the deaf-mute children at the Margate Asylum, the utility of the telephone has been proportionately more apparent. I will mention two cases in illustration. The first was that of a young woman with nerve deafness so extreme that it was necessary to speak at the top of one's voice within two or three inches of her ear to enable her to hear, but with the telephone I was able to converse in a subdued voice with my mouth 26in. away from the transmitter; in this case she received some assistance from reading my lips, though she was only a beginner in this accomplishment. The second case, a man with a similar degree of deafness, was able to hear his wife and myself conversing with him in tones hardly raised above a whisper, we being inside a room and he being outside with the door shut. Whether future experience will bear out my preliminary investigations only time will show; the opportunities of a provincial surgeon for carrying out extensive scientific observations are naturally limited." In the article there is given a short reference to the form of portable telephone employed, and a suggestion is made that the apparatus should be called a lamprophone. As for this latter point, since the instrument consists only of a transmitter, receiver, and three dry cells in a box, there does not seem any reason why it should require to give up its old name and take a new one, any more than do the induction coils and magnetos that are already in surgical use.

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RAILWAY BLOCK SIGNALLING.

BY J. PIGG.

(Continued from page 206.)

In a previous article reference was made to the liability to accident where the construction of the block instruments is such as to allow of the line being cleared before the train so signalled is out of the section. Such action, resulting from a lapse of memory on the part of the signalman at the receiving end of the section, was found to be cause of a very bad accident a few years ago. An experimental attempt to neutralise the effects likely to arise in this way for a three-wire single-needle circuit is shown by Figs. 48, 49, and 50.

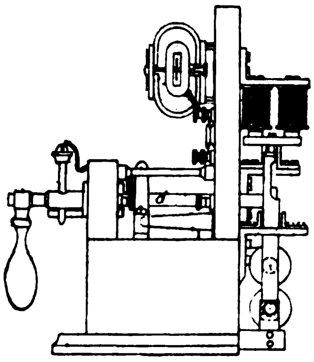

FIG. 48.—Case Removed, Instrument Locked (Right Elevation).

As will be seen from the figures, the apparatus provides for the locking of the instruments to "Train on line," after the usual distinguishing signals have passed, until the train, so signalled, has passed over a rail treadle, placed at a suitable point near the cabin at the receiving end of the section. The locking takes place at the receiving end of the section, and is due to concurrent action on the part of the signalmen at both ends.

The arrangement was not intended to relieve the signalman of the responsibility for seeing that the *whole* of a train previously signalled arrived and passed under the protection of his outdoor signals in accordance with the rules provided for working traffic, but was designed with a view to provide a check against any attempt he might inadvertently make to clear the line before the train reached a point which had previously been determined by the responsible officials to be outside the section referred to.

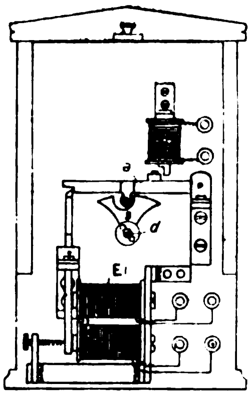

FIG. 49.—Back Elevation, Instrument Locked.

At the time the additional apparatus was designed, it was the rule for the signalman at the *sending* end to hold the instrument needles to "Train on line" until the signalman at the receiving end had inserted the peg as shown in Fig. 49. At the instant this was being done the batteries at both ends of the section were in use. Advantage was taken of this simultaneous use of both batteries to lock the handle of the receiving instrument in the "Train on line" position, so that if the peg was withdrawn before the proper time the instruments at both ends would still show "Train on line," and the signalman at the receiving end would be unable to move the handle to give "Line clear," or any other signal, until the instrument was unlocked by the direct action of the train signalled on its arrival at some point where at least a portion of the train had passed the signal cabin.

The additional apparatus consists of the differential electromagnet, E_1, which is connected as shown in Fig. 50, and the simple electromagnet, E, connected with the rail treadle. The commutator spindle, *d*, is prolonged through the back of the instrument, and carries the slotted sector, *s*. The rocking-bar, *a*, rides on the top of *s* when the handle of the instrument is vertical; and the armature of E_1 supports it, under the lower edge, during the time the instrument is being worked to send train-distinguishing signals, since E_1 is a differential electromagnet, and its armature is unaffected by currents originating at the receiving end.

During the time train-distinguishing signals are being received from the sending end of the section, the armature of E_1 is affected, but the handle of the receiving instrument being then vertical, *a* is upheld by *s*. If the handle of the instrument at the receiving end is held over so that the needles indicate "Train on line," the slot in *s* comes under the friction wheel of *a*, but the latter is still held up by the armature of E_1. If, now, the handle at the sending end is also held over, the previous balance of the currents in E_1 is upset, the armature is attracted and allows *a* to fall and lock the handle of the receiving instrument in the "Train on line" position. The only legitimate means of releasing the handle after the operations described is, as will be seen, by the current set up when the circuit of E is closed by the depression of the rail.

In Fig. 50 the handles of the instruments at both ends of the section are shown in the position to indicate "Train on line." It will, however, be clear from the description

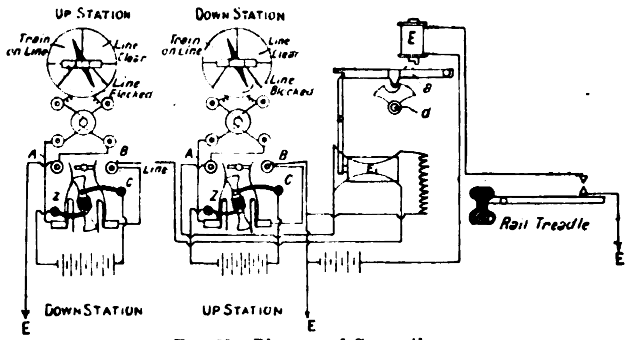

FIG. 50.—Diagram of Connections.

that the diagram represents the position of the handle at the sending station at the moment the instrument at the receiving station is being locked only. At other times the handle of the sending instrument stands vertical, as usual, and the "Train on line" indication is maintained by the position of the handle at the receiving end. As has already been said, this concurrent action of the two signalmen was the rule for working at the time the additional apparatus was designed. At present the method of working is different, but there is nothing in the requirements which is inimical to the working of the instruments as indicators.

The position of the releasing treadle requires judgment in its selection, and would probably, owing to local circumstances, be different at every place. Its position would also largely depend upon the rules in use by the particular company adopting any such method of automatic working. Some companies prohibit the acceptance of any train from the rear when the previous train is standing at the "advance" signal, although it is then protected by the "home" signal. Others prohibit the acceptance of passenger trains only under these circumstances, and allow goods or mineral trains to be brought to the "home" signal, when a similar train is standing at the "advance" signal, the "distant" being kept at danger during the approach of the second train.

Obviously, the point of release will be different in the two cases; for if the line may not be cleared until a train has passed the "advance" signal, the releasing point must be situated so that it cannot be actuated until the train has passed that signal, whilst, on the other hand, where the line is cleared when the train is within the "home" signal the releasing point must be selected at a point near that signal.

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This difference in practice is worthy of more notice. In the case where the line is not cleared until the train is passing the "advance" signal, the section obviously extends between "advance" and "advance." Where the line is cleared when the train is within the protection of the "home" signal, the section extends between the "advance" at the sending end and the "home" at the receiving end, and the part of the line between the "home" and "advance" signals is practically unblocked and worked under the observation of the signalman only.

Winter's Block Instrument.

Fig. 51 shows diagrammatically the construction of and connections for Winter's block instrument as arranged for double-line working, with one line wire and using transient currents. All distinguishing signals are given by a bell code, and the indicators are simply used to show the condition of the line for the time being.

The apparatus provided at one station for one section consists of a plunger key, P, a reversing switch, S W, a small push, V, and the two indicator dials. The indicating pointer for approaching trains is coloured red, that for receding trains is black. The soft-iron needles, *e e*, which are attached to the same axle as the indicating pointers, behind the dials, are polarised by the bar magnet, N S, and play between the pole-pieces of M_1 and M_2. The electromagnets, M_1 and M_2, are shown partly in front view and partly in side view. M_1 actuates the bell hammer, and M_2 actuates the polarised relay tongue, T. The relay, R, is a combined polarised and non-polarised electromagnet, and is also shown partly in front view and partly in side view in order to show the various actions more clearly. All currents passing through the coils of R cause the soft-iron armature, *a*, to be attracted; the tongue, *t*, is only attracted to the stud, W_1, when the current passes in the proper direction. The switch, S W, is a commutator for reversing the line battery. The carbon is attached to the axle which carries the stud shown; the zinc is connected to the bridge, *n*. If the handle of the switch is turned from "off," as shown, to "on," the stud brings the carbon into connection with the "on" line spring, and allows the "off" line spring to make contact with the bridge, *n*, and zinc. The plunger key, P, has three contact points between *l* and *f*, between *l* and *r*, and between the plunger and *g*. When the plunger is at rest *l* is in contact with *r*, and the other contacts are broken. When the plunger is depressed, contact is made between the plunger and *g* and between *l* and *f*, whilst the connection between *l* and *r* is broken. The insulating piece attached to *l* prevents contact between *l* and *g* when the plunger is depressed. The push, V, when depressed makes two contacts—one between *d* and *k*, and the other between *h* and *m*. The two connectors bridging *d* and *k* and *h* and *m* respectively when V is depressed, are fastened together by an insulating piece. The normal position of the switch, S W, is "off," and it is only brought into use for *approaching* trains. Signals originating at the station from which a train is being despatched are given with the switch at "off." The normal position of the indicators is to "Cleared line" when the section is not occupied. When a train is ready to proceed from the "up" station the operations to be gone through are as follows, for block working only:

Up Station.	Down Station.
Depresses P in accordance with code for "Is line clear" signal. Switch at "off."	
	Receives "Is line clear" signal on bell. Switch at "off." Puts switch to "on" and depresses P_1 in accordance with code for "Line is clear" signal.
Receives "Line is clear" signal on bell. Depresses P in accordance with "Line is clear acknowledgment" signal, and at the same time depresses V. "Train going to" indicator put to "On line."	"Train coming from" indicator put to "On line."

On the arrival of the train at the down station:

Up Station.	Down Station.
	Puts switch to "off" and depresses P_1 in accordance with "arrival" signal.
Receives "arrival" signal on bell. Depresses P in accordance with "Arrival acknowledgment" signal, and at the same time depresses V. "Train going to" indicator put to "Cleared line."	"Train coming from" indicator put to "Cleared line."

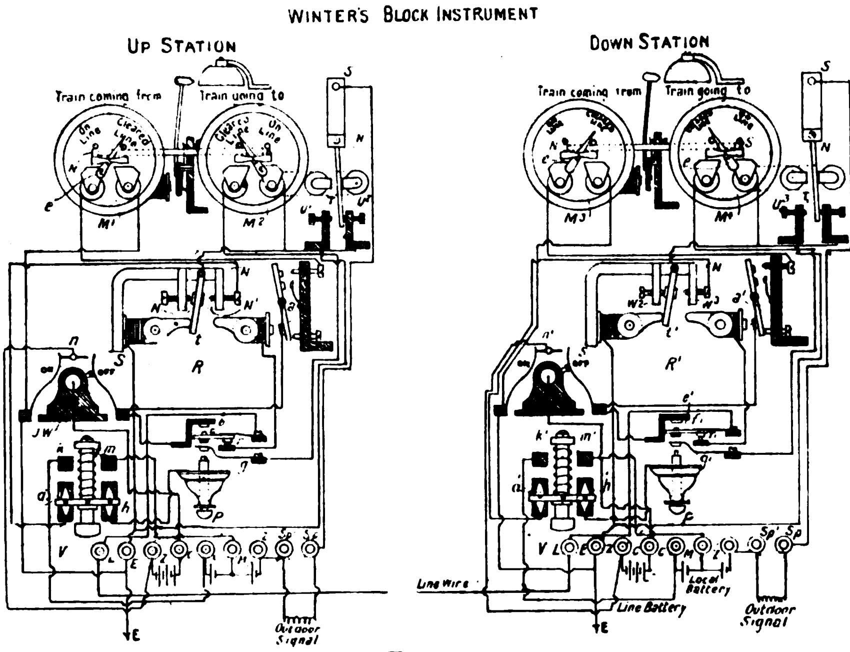

Fig. 51.

The paths of the various currents are as follows:

"Is line clear" signal.

From the line battery, C, through the axle, S W, "off" line spring *f*, *l* to the line L.	From the line L, through *r* and the coils of R_1 to earth.
From earth, through "on" line spring and bridge, *n*, to Z.	a_1 is attracted. Local action, ringing bell (line battery): From C through axle S W_1, "off" line spring M_3, "on" line spring and bridge, *n*, to Z.
	"Line is clear" signal. Switch at "on." From C through axle S W_1 to earth.
From earth, through coils of R, and *r* to line L.	From line L, through l_1, f_1, and "off" line spring to Z.

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t is moved to W_1, but no current is established owing to the break in local circuit between *d* and *k*.
a is attracted, ringing bell.
Local action (line battery):
From C through axle S W, "off" line spring M_1, "on" line spring and bridge, *n*, to Z.

"Line is clear" acknowledgment.

Line battery.
From C through axle S W, "off" line spring *f*, and *l* to line L.

From line L, through r_1 and coils of R_1 to earth.

From earth, through "on" line spring and bridge, *n*, to Z.

a_1 is attracted.
S W_1 is to "on."

Local battery C M Z.
From C, through K, *d*, W_1, *u*, T, and outdoor semaphore to Z.

From C, through axle S W_1, "on" line spring M_3, "off" line spring and bridge, *n*, to Z.
This puts "Train coming from" indicator to "On line."

Local battery M Z.
From M, through *m*, *h*, P, *g*, M_2, *u*, T, and outdoor semaphore to Z.
This puts "Train going to" indicator to "On line."

Where the outdoor mechanical signal is interlocked with the block instrument, a slight variation in the order of the operations is made. This consists in depressing V alone, at the sending end, after the receipt of the "Line is clear" signal, and before the "Line is clear acknowledgment" signal. This completes the circuit of C M Z alone, and unlocks the mechanical signal. The subsequent depression of V, together with P, for the "Line is clear acknowledgment" signal moves the tongue, T, against u_1, and prevents any current being sent to the outdoor signal locking apparatus until after the "arrival" signal has been received and acknowledged.

When the train, the signalling of which has been traced in the route diagrams, arrives at the down station, the switch, S W_1, is put to "off," and the plunger, P, is depressed in accordance with the "arrival" signal. This signal simply rings the bell at the up station and puts *t* back to W. When the "Arrival acknowledgment" signal is sent in reply from the up station, the currents established by P and V place the indicators at both stations to "Cleared line" and the relay tongue, T, to u_2.

The paths of the currents are easily traced when it is remembered that the switch at the down station has been put to "off." The local current at a_1 (down station) is reversed, and puts the indicator at that place to "Cleared line." The indicator at the up station is placed to "Cleared line" by the action of the battery, C M, the current passing through V.

The interlocking of the starting signal with the block instrument is shown by Figs. 52, 53, and 54. The crank of the lever, L (Fig. 52), is worked by the signal lever in the cabin, but its operation differs from that of most signal levers in that it is not required to hold L up during the time the signal is "off." Fixed to the axle of L, and working with it, is the cam lever, *c*. Immediately above *c*, and in contact with it, is the straight lever, *l*, with its counterweight, *w*. At right angles to *l* is the counterweight, w_1, carried by a crank pivoted at *p*, the short arm, *k*, of which bears against *l* when the latter is horizontal. If the lever L is raised *l* is also raised by the cam, *c*, and *k*, by the falling of w_1, is brought under *l*, and supports it when the lever L has returned to the position shown in Fig. 52. Fig. 53 is drawn to show the positions of the various parts of the apparatus at this stage. So far as the mechanical portion of the apparatus is concerned, the signal arm is free to take up the "off" position, but it is still held up by the electrical interlocking apparatus, which is contained in the box, B, at the top of the post.

The mechanism connected with the electrical interlocking is shown separately in Fig. 54. It consists of the simple electromagnet, R_3, its armature, *i*, and three cranks, one of which carries the hammer, *f*. The axle of the signal arm is shown at *a*. The lever, *b*, and the projection, *m*, work with *a*, and under normal conditions *b* is locked by c_1. Before the releasing current passes through R_3 the lever, *g*, is locked by the armature, but when the armature is attracted *g* is released, and *f* falls upon *e* and releases *b*. If the operation of L, previously described, has been performed before the releasing current passes, or is performed after, the signal arm falls. The projection, *m*, engages with *n*, when the axle, *a*, turns and raises the hammer, *f*, and *g*, engaging with the armature, *i*, locks *f* in the position it previously occupied. When the train passes the signal, the depression of F pulls *k* from under *l*, and the weight, *w*, being free to fall raises the arm to a horizontal position again.

The apparatus is now fully in position for a similar cycle of operations. The signalman, however, is not able to again lower the signal arm until the "arrival" signal has been received and acknowledged for the last train signalled, owing to the tongue, *t*, of the relay, R, being in contact with W_1 (Fig. 51) during the time the "On line" indication is being exhibited.

It will be noticed from the description of the apparatus and the method of working that the principal objects aimed at in the design are concurrent action on the part of the two signalmen concerned before the section can be occupied or the signal lowered for a train to pass forward, and automatic protection of the section occupied by the raising of the signal to danger by the passage of the train over the rail treadle. The apparatus provides, indirectly, by the position of the switch, an indication similar to "Line clear (section ready for train to enter) at the receiving end, but does not provide a similar indication at the sending end.

WINTER & CRAIK'S
ELECTRICALLY INTERLOCKED SEMAPHORE

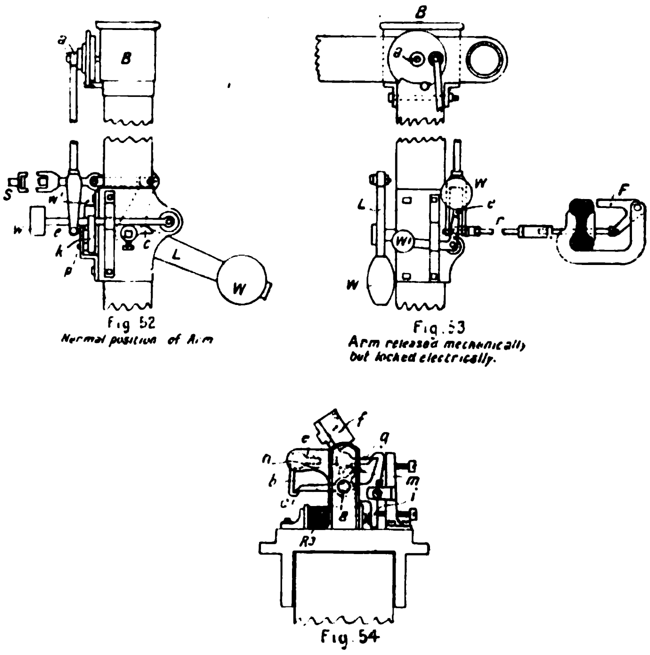

Fig 52 Normal position of Arm
Fig. 53 Arm released mechanically but locked electrically.
Fig. 54

(*To be continued.*)

THE PRINCIPLES OF ALTERNATE-CURRENT WORKING.*

BY ALFRED HAY, B.Sc.(EDIN.), A.I.E.E.

(*Continued from page 208.*)

48. The shape of the E.M.F. curve of an alternator may be determined experimentally by the use of an "instantaneous" contact maker, first introduced by Joubert. The action of this device will be best understood by reference to Fig. 40, which shows the arrangement of apparatus required for determining the shape of the E M.F. curve. T_1 and T_2 are the two terminals of the alternator. E D is an ebonite disc (10in. or 12in. in diameter) which is mounted on the alternator shaft, and which has a thin strip of brass, S, let into its circumference. This strip of brass is connected by means of a wire, W, to an insulated collar, I C,

* Based on a series of evening lectures delivered at the University College, Liverpool.

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also mounted on the shaft of the alternator. Two brushes, B_1 and B_2, rest, the one on the circumference of the ebonite disc, the other on the insulated collar. The tip of the brush B_1 must be very narrow, so that as the disc, E D, revolves contact is established between B_1 and S once in every revolution for a very short interval of time only. The brush B_1 slides on a graduated scale, G S. By varying the position of the brush B_1 we alter the instant at which contact is made with S. The brush B_1 is in connection with one of the alternator terminals, T_1, while B_2 is connected to one terminal of a condenser, the other terminal of which is connected to the alternator terminal T_2. As the alternator revolves, the condenser is connected, in a certain position of the armature depending on the position of the brush B_1 to the terminals of the alternator. As explained above, this contact is of very short duration. By the rapid succession of these brief contacts the condenser becomes charged to, and is maintained at, a P.D. equal to that between the alternator terminals *at the instant when*

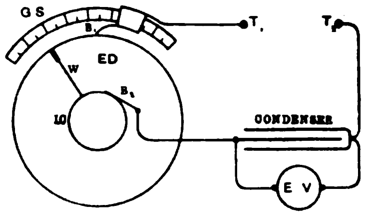

FIG. 40.

contact is made. By determining this P.D. for different positions of the brush B_1 we obtain the shape of the E.M.F. curve, equal displacements of B_1 along its scale corresponding to equal intervals of time.

The P.D. between the condenser terminals may be measured by means of an electrometer or an *electrostatic* voltmeter (E V in Fig. 40). The scale of an electrostatic voltmeter is, however, generally so restricted that it would be difficult to obtain accurate readings over the whole range required. This difficulty may be got over by the ingenious device, due to Dr. Fleming, of using an auxiliary E.M.F. in the electrometer circuit. Thus, let us suppose that when the brush B_1 is in a certain position the corresponding P.D. is too small to be read on the electrostatic voltmeter. We have merely to connect (Fig. 41) a certain number of cells (secondary cells are very convenient for this purpose) in series with the voltmeter, and so as to increase the deflection until it can be read accurately on the voltmeter scale. By subtracting from this reading the E.M.F. of the cells, we obtain the P.D. at the condenser terminals. The same method may be used for reducing the voltmeter reading should the latter prove too high. In this case the cells are connected so that their E.M.F. opposes the P.D. at the condenser terminals, and this P.D. is obtained by *adding* the E.M.F. of the cells to the voltmeter reading.

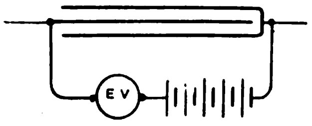

FIG. 41.

Since an electrostatic instrument is used, it might be thought that the condenser is unnecessary. This would be the case if the insulation of the voltmeter were perfect Owing, however, to the leakage which takes place, it is desirable to give the instrument a large capacity, and this is accomplished by connecting a condenser across its terminals. Even then a certain appreciable amount of leakage may take place, and this will depend on the interval which elapses between two consecutive contacts—*i.e.*, on the speed of the alternator. It is, therefore, always best to calibrate the combination of electrostatic voltmeter and condenser for the particular speed used by applying a known *steady* P.D. to the points T_1 and T_2 of the circuit (Fig. 40), and noting the corresponding reading of the electrostatic voltmeter. If the insulation of the condenser is very high, it will probably be found that there is no appreciable difference between the two readings obtained when the contact is stationary and running respectively. But with a slightly leaky condenser such a difference might exist, and a comparison of the two readings supplies a correcting factor, by which the readings of the electrostatic voltmeter must be multiplied, in order to give the correct values of the instantaneous P.D.

49. The method just explained for determining the shape of the E M.F. wave may also be used for the determination of the *current* wave in an inductive circuit. Fig. 42 shows the arrangement of connections required for this purpose. I R is the inductive circuit in which the current-wave is to be determined; N R is a small non-inductive resistance connected in series with the inductive resistance. The readings obtained with the brush B_1 placed in different positions give us the corresponding instantaneous P.D.'s at the terminals of the non-inductive resistance. Now, since a non-inductive resistance is incapable of offering a counter E.M.F. to a varying current it follows that at every instant the current through such a resistance is simply equal to

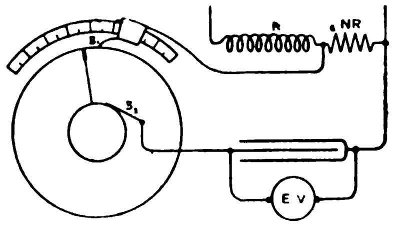

FIG. 42.

the quotient of the P.D. by the resistance. Hence, by dividing the values of the instantaneous P.D. by the resistance we obtain the corresponding values of the current.

In order that the introduction of the non-inductive resistance may not affect the existing conditions of the circuit to any great extent, it is desirable to make this resistance as small as possible. The P.D.'s, however, which will have to be measured in that case will also be small, and an electrostatic voltmeter would not be suitable for this purpose. The best instrument in this case would be an electrometer used heterostatically—*i.e.*, with its needle charged to a high potential and insulated from the quadrants. *Good* electrometers, however, are very expensive instruments, and are not available in every laboratory. A good substitute for an electrometer is provided by the combination of a slide-wire with a galvanometer and an auxiliary source of E.M.F. The arrangement of connections is shown in Fig. 43, where A B represents the slide-wire along which

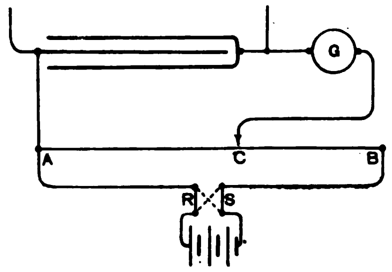

FIG. 43.

passes a steady current supplied by some constant source of E.M.F. (such as a secondary cell). A reversing switch, R S, is included in this circuit. The point A, being permanently connected to one terminal of the condenser, is maintained at the same potential as that terminal. When the sliding contact of the bridge wire is momentarily depressed at C, it connects the point C to the other terminal of the condenser through the galvanometer, G. If these two points happen to be at the same potential, no current will pass through the galvanometer. The position of C is adjusted until the galanometer fails to show any deflection. It is obvious that under these conditions the P.D. at the condenser terminals is proportional to the length A C, which is read off on the slide-wire scale.* In order to determine the constant which will convert the

* On the supposition that the resistance of the wire per unit of length is uniform. If this is not the case, the wire must be specially calibrated.

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scale readings into amperes, a *known* steady current is passed through the non-inductive resistance, N R, the instantaneous contact-maker running at the speed at which it is to be used, and the corresponding scale reading is noted.

By taking corresponding sets of readings for the P.D. and current in any inductive part of a circuit, and plotting the results obtained on a sheet of squared paper, we not only determine the shape of the P.D. and current waves, but also their phase relation, a knowledge of which is frequently of great importance.

Various modifications of the methods just described for determining the wave-shape have been used by different experimenters, and some important improvements have been introduced into these methods recently. The determination of the wave-shape by the methods given above is a somewhat tedious process, on account of the comparatively long time required to obtain a set of readings. By means of suitably-designed apparatus the wave-shape may be obtained much more quickly.

In some cases it may be necessary to determine the wave-shape when the alternator is not accessible. A special form of apparatus for this purpose has been designed by Dr. Fleming, and another form by Dr. Hicks. In both cases a *synchronous* alternating-current motor is used for driving the instantaneous contact-maker. By a *synchronous* motor is meant one whose speed bears a definite ratio to the periodicity of the alternating current.

(To be continued.)

ON THE MEASUREMENT OF THE INSULATION RESISTANCE OF CONTINUOUS-CURRENT THREE-WIRE SYSTEMS WHILE AT WORK.

BY EDWIN J. HOUSTON, PH.D., AND A. E. KENNELLY, SC.D.

A three-wire system for incandescent lighting may be—

(*a*) Contained within the walls of a single building and have an insulation from ground of hundreds or thousands of ohms.

(*b*) It may extend over a large network of buried conductors in streets, and have an insulation so low as to be measurable in ohms, or decimals of an ohm.

(*c*) It may be grounded permanently at its neutral, in which case the insulation is, of course, nil.

It is here proposed to consider systems corresponding to classes (*a*) and (*b*), which may be considered as insulated systems, in contradistinction to systems of class (*c*), which are uninsulated systems.

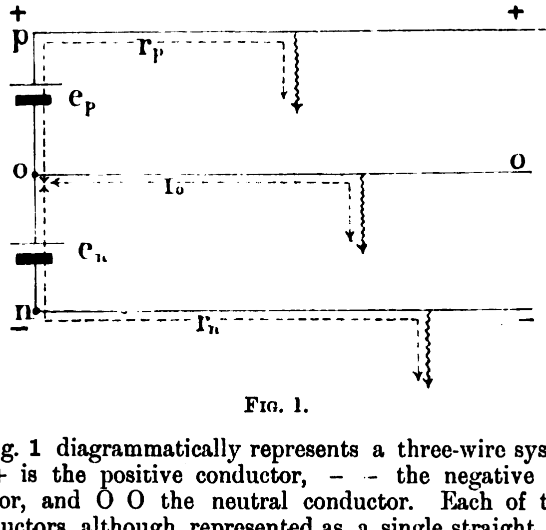

FIG. 1.

Fig. 1 diagrammatically represents a three-wire system. + + is the positive conductor, – – the negative conductor, and O O the neutral conductor. Each of these conductors, although represented as a single straight line, may be considered as spreading, branching out, and ramifying over a network of any degree of complexity. These feeders or mains are supplied by two E.M.F.'s of e_p volts on the positive side, and e_n volts on the negative side respectively, their sum $e_p + e_n$ being E volts. Each of the three conductors has electric leakage distributed along it in any manner. Between them are connected lamps or other translating devices. Under these conditions, the conductors will behave as though they possessed single resultant leaks of r_p, r_o, and r_n ohms respectively, including the conductor resistances up to the resultants, and measured from the neutral bus bar, *o*, or common connection, r_p and r_n therefore include the small resistances in the generator armatures. It may be considered that for all practical purposes these apparent insulation resistances do not depend upon the load on the system, or, in other words, that the drop of pressure in the conductors when loaded is relatively too small to affect the apparent resistances up to and included in the resultant faults. On this assumption we may safely ignore the load on the system, and consider the system as completely unloaded, and as represented in Fig. 1, where the only currents which flow are leakage currents.

Let the potentials between the points *p*, *o*, and *n* and the ground be measured and denoted by u_p, u_o, and u_n respectively. If the insulation of the system were perfect, and each of the two E.M.F.'s, e_p and e_n, equal, the potential at *o* would be zero, while those at *p* and *n* would be $+e_p$ and $-e_n$ volts respectively. The slightest dissymmetrical leakage in the system would, however, change this distribution; such, for example, as the connection of a grounded voltmeter to either *p* or *n*. In almost all practical cases, however, the influence of the leakage effected through the resistance of a high-resistance voltmeter is negligible, and the potentials at *p*, *o*, and *n* are:

$$u_p = \frac{g_o e_p + g_n E}{G} \text{ volts} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

$$u_o = u_p - e_p = \frac{g_n e_n - g_p e_p}{G} \text{ volts} \quad . \quad . \quad (2)$$

$$u_n = u_p - e_p - e_n = u_o - e_n = -\frac{g_o e_n + g_p E}{G} \text{ volts} \quad (3)$$

where g_p, g_o, and $g_n = \frac{1}{r_p}\ \frac{1}{r_o}$ and $\frac{1}{r_n}$ mhos respectively (4)

also $\quad G = g_p + g_o + g_n$ mhos . . . . (5)

$$E = e_p + e_n \text{ volts.}$$

For example, if $r_p = 100$ ohms, $g_p = \frac{1}{100} = 0{\cdot}010$ mho

$r_o = 200$ ohms, $g_o = \frac{1}{200} = 0{\cdot}005$ mho

$r_n = 250$ ohms, $g_n = \frac{1}{250} = 0{\cdot}004$ mho

G $= 0{\cdot}019$ mho

Also if $e_p = 120$ volts

$e_n = 120$ volts

$$u_p = \frac{0{\cdot}005 \times 120 + 0{\cdot}004(120+120)}{0{\cdot}019} = 82{\cdot}12 \text{ volts}$$

$$u_o = \frac{0{\cdot}004 \times 120 - 0{\cdot}01 \times 120}{0{\cdot}019} = -37{\cdot}88 \text{ volts}$$

$$u_n = -\frac{0{\cdot}005 \times 120 + 0{\cdot}01\ (120+120)}{0{\cdot}019} = -157{\cdot}88 \text{ volts.}$$

Theoretically, it is evidently only necessary to observe one potential, since the difference between any pair of the potentials is the E.M.F. between them as supplied at the generator terminals.

It is evident that when a ground occurs on one conductor, its potential becomes zero. If a ground occurs on the positive conductor, there is a tendency to the condition

$$u_p = o\,;\ u_o = -e_p\,;\ u_n = -E.$$

If a ground occurs on the negative conductor, the tendency is to be the condition

$$u_p = E\,;\ u_o = e_n\,;\ u_n = o\,;$$

and if the ground occurs on the neutral main, the corresponding condition is

$$u_p = e_p\,;\ u_o = o\,;\ u_n = -e_n.$$

Consequently, a high reading on an outside conductor indicates a ground on the opposite outside conductor, while equal and opposite potentials on the outside conductors

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indicate symmetrical leakage—that is to say, leakage which may be either great or small, but is either on the neutral conductor or symmetrically distributed with regard to it.

While, therefore, a voltmeter connected to one of the outside conductors of a three-wire system gives qualitative information concerning the insulation of the system, it gives but little quantitative information.

We propose to show how such quantitative information may be obtained. So far as the authors are aware, no method has been published for the determination of the three insulation resistances, r_p, r_o, and r_n, during the working of the system, without the use of a Wheatstone bridge of special construction.

The first step is to find G, the joint insulation conductance of the system, by a method already known. For this purpose a leak of g mhos is connected to one of the bus bars at the central station, say at O, Fig. 1. Then u_o falls to $u_o{}^1 = \frac{g_n e_n - g_p e_p}{G + g}$ volts (6). That is to say, the potential of the neutral bus bar is lowered in the ratio $\frac{G}{G+g}$. The same is true if this single link be applied successively at p and at n when

$$u_p{}' = \frac{g_o e_p + g_n E}{G + g}; \text{ and } u_n{}^1 = -\frac{g_o e_n + g_p E}{G + g} \text{ volts} \quad . \quad (7)$$

successfully and respectively. In other words, the leak, g, lowers the potential of the bus to which it is connected in the ratio of $\frac{G}{G+g}$. If $g = G$, this ratio will be one-half, so that if a leak be applied to one of the bus bars, and adjusted so that the potential of the bus is thereby halved, the conductance of the leak is equal to the insulation conductance of the entire system, including all three conductors. If the leak, g, cannot be so adjusted, we have the relation :

$$G = g\left(\frac{u'}{u - u'}\right) \text{ mhos} \quad . \quad . \quad . \quad . \quad (8)$$

This result, or its equivalent, was first pointed out by Dr. O. Frölich in the *Elektrotechnische Zeitschrift*, January, 1893.

For example, in the case last considered, suppose a conductance of $g = 0{\cdot}025$ mho (40 ohms) connected to the neutral bus bar, then by (6)

$$u_o{}^1 = \frac{0{\cdot}004 \times 120 - 0{\cdot}01 \times 120}{0{\cdot}019 + 0{\cdot}025} = -\frac{0{\cdot}72}{0{\cdot}044} = -16{\cdot}36 \text{ volts,}$$

and by (8) $G = 0{\cdot}025\left(\frac{-16{\cdot}36}{-37{\cdot}88 + 16{\cdot}36}\right)$

$$= 0{\cdot}025 \times \frac{-16{\cdot}36}{21{\cdot}52} = 0{\cdot}019 \text{ mho,}$$

so that the resultant fault, $\frac{1}{G}$, in the system has a resistance of $\frac{1}{0{\cdot}019}$, or 52·6 ohms. This test, therefore, determines $G = g_p + g_o + g_n$. If e_p and e_n are made equal for the purposes of a brief test, we obtain one other relation between the required quantities g_p, g_o, and g_n — namely, when $e_p = e_n$,

$$g_n - g_p = \frac{G}{E}(u_p + u_n) \text{ mhos.} \quad . \quad . \quad (9)$$

Thus, in the preceding example, since we have already assumed $e_p = e_n$,

$$g_n - g_p = \frac{0{\cdot}019}{240}(82{\cdot}12 - 157{\cdot}88),$$

$$= \frac{0{\cdot}019 \times -75{\cdot}76}{240} = -0{\cdot}006 \text{ mho.}$$

$$\therefore g_p - g_n = 0{\cdot}006 \text{ mho.}$$

It would appear that no combination of leaks applied to the system suffices to supply another independent relation between g_p, g_o, and g_n, so that while equation (8) gives the aggregate or joint leakage conductance of the system, one more independent equation is needed besides (9) to determine the separate conductances g_p, g_o, and g_n, unless one of them is very great—*i.e.*, unless one conductor is grounded.

Referring, however, to equation (1) we find that if we alter the E.M.F. e_n by an amount Δe_n, we produce an alteration in u_p of

$$\Delta u_p = \frac{g_n \Delta e_n}{G} \quad . \quad . \quad . \quad . \quad (10)$$

so that $g_n = \frac{G \, \Delta u_p}{\Delta e_n}$ mhos . . . (11)

Similarly, in equation (3) a change of e_p produces a change in u_n of $\Delta u_n = -\frac{g_p, \Delta e_p}{G}$ . . . . (12)

from which $g_p = -\frac{G \, \Delta u_n}{\Delta e_p}$ mhos . . . (13)

Consequently, to make this test we introduce suddenly as large a variation in e_p, and then in e_n, as the system will permit. The corresponding changes in u_n and u_p are noted. From these g_n and g_p may be computed as above.

Thus, in the case considered, let e_p be suddenly increased from 117 to 123 volts, e_n remaining at 120. The potential at the opposite side of the system would correspondingly fall from $u_n = -156{\cdot}32$ volts to $u_n = -159{\cdot}48$ volts. Again, let e_n be suddenly increased from 117 to 123 volts, e_p remaining at 120. The potential at the opposite side of the system would correspondingly rise from $u_p = 81{\cdot}47$ volts to 82·73 volts :

By (11) $g_n = 0{\cdot}019 \times \frac{1{\cdot}26}{6} = 0{\cdot}004$ mho, $\therefore r_n = 250$ ohms.

By (13) $g_p = -0{\cdot}019 \times \frac{-3{\cdot}16}{6} = 0{\cdot}010$ mho, $r_p = 100$ ohms.

Equation (9) supplies a check to these two values. Finally, $g_o = G - (g_n + g_p) = 0{\cdot}019 - 0{\cdot}014 = 0{\cdot}005$ mho, $\therefore r_o = 200$ ohms. Consequently, when a change in the E.M.F. on one side of the system produces very little change in the opposite potential, the leakage on that side is small compared with the total leakage of the system, and *per contra*.

The measurement is best conducted with the aid of storage batteries ; otherwise, the variations ordinarily occurring in the pressures between bus bars may mask the changes effected as described. If the test is conducted during the daytime, the temporary disturbances of pressure it produced over the system will not be so objectionable.

As another example of the application of the method, suppose a three-wire system and the following observations made at the central station :

$e_p = 120$; $e_n = 120$; $u_n = -91\frac{3}{4}$ volts.

A leak of 10 ohms, $g = 0{\cdot}1$ applied at n changed u_n to $-74\frac{1}{3}$.

$e_p = 120$; $e_n = 117$ changed to 123, u_p changed from -91 to $-92{\cdot}5$.

$e_n = 120$; $e_p = 117$ changed to 123, u_n changed fron $146\frac{3}{4}$ to $149\frac{1}{2}$.

Required the insulation resistance of the three main conductors.

Here by (8)

$$G = 0{\cdot}1\left(\frac{-74{\cdot}33}{-91{\cdot}75 + 74{\cdot}33}\right) = 0{\cdot}427 \text{ mho} = 2{\cdot}34 \text{ ohms.}$$

By (11) $g_n = 0{\cdot}427 \times \frac{2{\cdot}75}{6} = 0{\cdot}196$ mho = 5·10 ohms.

By (13) $g_p = -0{\cdot}427 \times \frac{-1{\cdot}5}{6} = 0{\cdot}107$ = ·35 ohm.

0·303 0·303

$g_o =$ 0·124 = 8·06 ohms.

In cases where one conductor is grounded through a small resistance, the leakage conductance of that conductor, and therefore of the system, becomes so large that the method fails. It is always possible, however, to measure the resistance of the leak in the grounded conductor, including the resistance of the conductor up to the ground,

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Thus, in Fig. 2, let G be the ground on the neutral conductor, through a small resistance, r_0; A is an ammeter, and r a suitable resistance of German silver or other alloy of constant resistance; S is a ground-switch for making good

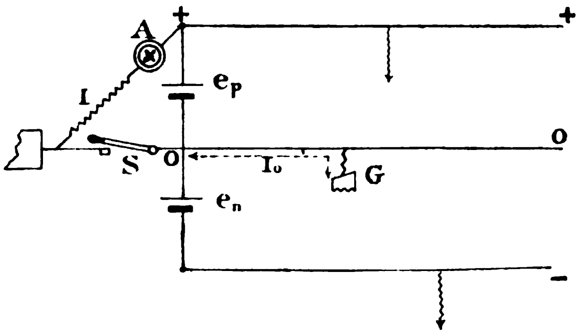

FIG. 2.

connection between ground and the neutral bus. Then the current, i, through the ammeter will be with switch open:

$$i = \frac{e_p}{r + r_0} \text{ amperes} \quad . \quad . \quad . \quad . \quad (14)$$

with the switch closed

$$i^1 = \frac{e_p}{r} \text{ amperes} \quad . \quad . \quad . \quad . \quad (15)$$

$$\therefore r_0 = r\left(\frac{i - i^1}{i}\right) = \frac{e_p}{i^1}\left(\frac{i - i^1}{i}\right) \text{ ohms} \quad . \quad . \quad (16)$$

or,

$$g_0 = g\frac{i}{i - i^1} = \frac{i^1}{e_p}\left(\frac{i}{i - i^1}\right) \text{ mhos} \quad . \quad . \quad (17)$$

Thus, a three-wire system with uninsulated or imperfectly grounded neutral and E.M.F. e_p – 120 volts gave 11·43 amperes with the neutral ground-switch open, and 12 amperes with the switch closed, the resistance, r, being 10 ohms ($g = 0{\cdot}1$).

By (17) $g_0 = \frac{0{\cdot}1 \times 11{\cdot}43}{12 - 11{\cdot}43} = \frac{1{\cdot}143}{0{\cdot}57} = 2$ mhos.

$$r_0 = \tfrac{1}{2} \text{ ohm.}$$

RÉSUMÉ.

The means of determining the joint leakage conductance of a three-wire system are already known, but no means appear to be known for determining the individual leakage conductances of the three separate conductors under load, except by the use of the Wheatstone bridge. It is here shown (1) how the individual leakage conductances may be approximately determined by varying the working pressure on one side of the system, and observing the corresponding variation of potential to ground on the other; (2) how the resistance in and up to the ground of a grounded conductor under load may be measured from the central station.—*The Electrical World.*

THE "VANBE" ARC LAMP.

We were invited on Monday last to inspect this arc lamp, which is being manufactured by Messrs. Vaughan and Brown, of Kirby-street, E.C. We understand that this lamp has found favour with the officials at Woolwich Arsenal, where about 200 of these lamps are now in use. The success of the lamp, after an extended trial at the arsenal, and in other installations erected by Messrs. Vaughan and Brown, has led the firm to put the lamp on the market. The general arrangement of the mechanism can be seen in Fig. 1. The feeding gear has a positive drive, actuated by an oscillating armature, A. This armature is acted on by the two magnet cores energised by the shunt coils, S S. The resistance of these shunt coils is about 500 ohms. When the armature is drawn towards the core the circuit is broken at the contact breaker, F. In fact, these parts act in the same way as the mechanism in a trembling bell. The armature is attached to the brass lever, B, at the upper end of which is hinged the pawl gearing in the ratchet wheel, R. A spring also attached to the end of this lever keeps the armature away from the magnets normally. The forward motion is given to the ratchet wheel by the tension in the spring after the contact has been broken. The backward motion of the pawl is caused by the magnetic attraction. The shaft on which the ratchet wheel is geared has a thread cut on it, W, which gears in a worm-wheel. Fastened to the worm-wheel is the wheel C, round which passes the chain. One end of the chain is attached to each carbon-holder, so that the lamp is approximately a focussing one. The upper carbon descends as the lower carbon ascends and by an equal amount. So if the diameters of the two carbons are correctly chosen so that equal lengths are consumed of each, the position of the arc in the globe does not vary. The feeding of the lamp is thus effected by the shunt coils, and the individual impulses moving the carbons together are exceedingly small. When adjusted, the lamp feeds one tooth of the ratchet wheel at a time, and this with the worm gear used is equivalent to shortening the arc about $\frac{1}{300}$in. No dash-pot is required with this feed, as on account of the nature of the driving gear no sudden change can occur.

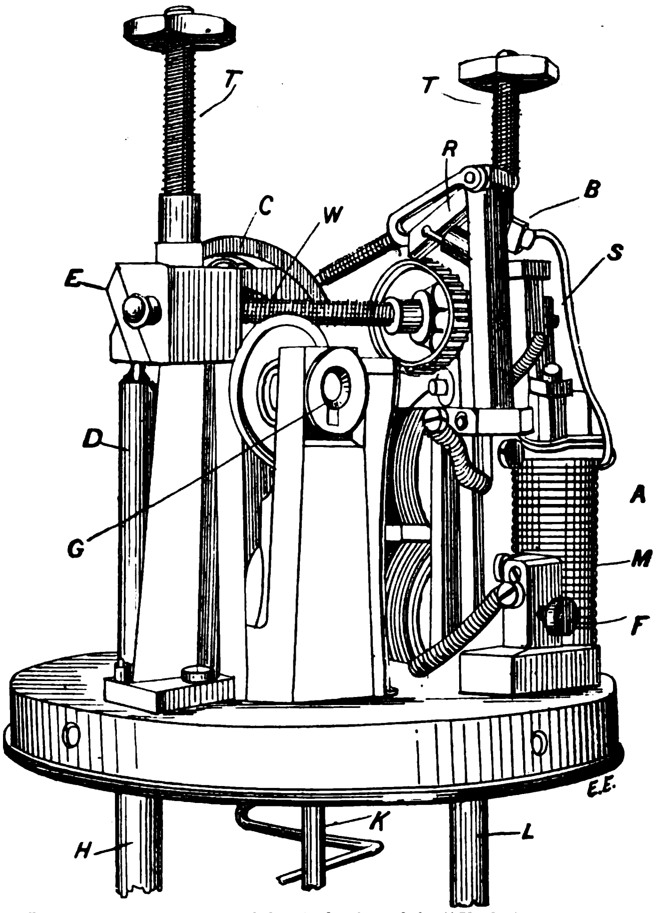

FIG. 1.—Prospective View of the Mechanism of the "Vanbe" Arc Lamp.

The next point to be considered is the striking of the arc when the shunt coils cause the carbons to touch. To separate the carbons the worm-shaft is arranged to have two motions. The first is the rotating motion giving the feed, and the second a horizontal movement to strike the arc. At one end of the shaft a horseshoe electromagnet is placed, wound with thick wire, M, in series with the arc. The armature of this magnet when attracted to the cores presses on the end of the worm-shaft, causing it to move a predetermined amount. The threads on the shaft, gearing with the worm-wheel then act as a rack and cause the wheel to revolve, separating the carbons. In the new position thus taken up by the shaft the feeding gear acts as before. Having described the main principles of the lamp, the individual details deserve special attention. It is to these details, and to the workmanship of the whole, that the success of any arc lamp is due. Although anyone with the smallest experience can design a lamp to give comparatively satisfactory results in the laboratory, very few of the new lamps brought out can stand a test after two years' working outdoors. In the lamp before us great attention

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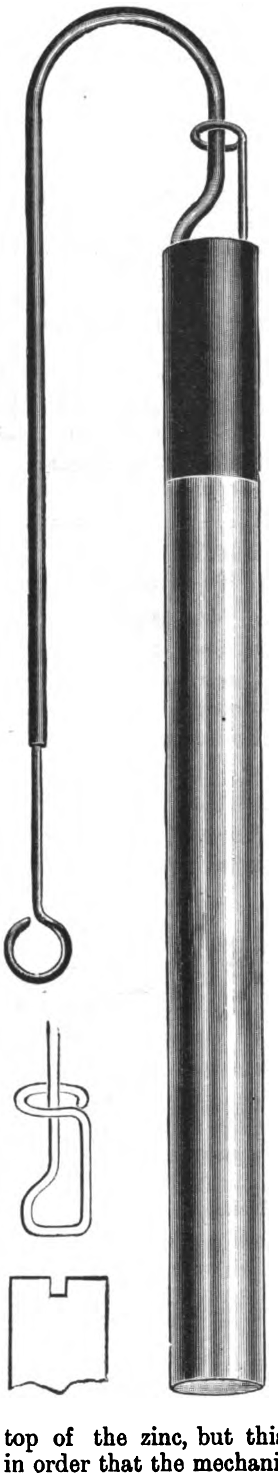
has been paid to the design of details. For instance, the worm-shaft is supported at either end on ball bearings, which are arranged so as to be easily adjusted in the first instance. Besides securing perfect alignment and little friction in working, this arrangement enables the worm to be placed exactly in pitch to the wheel. The chain which gears in the wheel, C, is made of steel, and great care has been exercised to ensure uniformity in the dimensions of the several links. The chain is brass-plated, to guard against rust, and gears in the wheel without slip. In order to prevent this chain from leaving the wheel it is passed through a guide, D, on its way down to the rod, H. A guard, concentric with the chain wheel, C, is placed at such a distance from the wheel that the chain cannot slip out even when slack. In moving the carbon-holders apart for retrimming, a ratchet on one side of the chain wheel gives the necessary release from the worm-wheel. A convenient arrangement in connection with the pawl of the ratchet allows the chain wheel to revolve in either direction with freedom when required. The arrangement of carbon-holder supports is not unlike many others on the market except in detail. The upper carbon-holder frame embraces one rod and rests against the other. In the embracing brush, roller bearings are provided to diminish friction. The lower carbon-holder frame on one side passes up the inside of the tube, H, the other end of the frame resting on the opposite rod. Down this latter rod is passed the insulated wire conveying the current to the lower holder. Porcelain insulation is used for this holder and for the contact breaker, F. The carbon-holders are arranged with spring grips and ball centreing gear. The terminals, T T, can be seen at the top of the lamp. These project through the cover, and the under nut is used as a means of fastening the case on to the main frame.

FIG. 2.—General View of the "Vaube" Arc Lamp.

The parts of the lamp are all made to gauge so as to be readily interchangeable. The cases for indoor and outdoor work have been designed with care, and the globe-lowering arrangement seen in Fig. 2 is very neat. The only trouble we find likely to occur is due to the want of recuperative power after a mushroom has temporarily short-circuited the carbon. The series coil is then powerless to lengthen the arc. Using good carbons, and with careful adjustment, this can be avoided. We are informed that a number of these lamps has also been supplied to the General Post Office, and that at the Woolwich Arsenal as many as 12 lamps are being run in series. The lamps for use in this circuit are provided with a cut-out and equivalent resistance. The resistance wire is wound on fireproof insulation round the outside of the cast.

The cut-out is compound wound, and protects the lamps when first switched in. As they do not all have the same distance to feed, the voltage on the lamp in which the carbons touches last rises. Thus, if all the lamps but one have feed down, this voltage across the shunt coils of the last lamp would be practically the full voltage of the circuit. Instead of this dangerous condition, the cut-out goes and inserts a resistance equivalent to the impedance of the lamp in the circuit. The main current is thus established, and the lamp, although cut-out, continues to feed till the carbons touch. This short-circuits the resistance and releases the cut-out. Thus the cut-out automatically cuts in, and is in this respect a most valuable adjunct to the lamp.

THE PARSONS IMPROVED LECLANCHE BATTERY ZINCS.



One weak point in ordinary Leclanché cells is the liability of the zinc terminal wire to break off short where it joins the zinc rod. This has been due to two causes—*i.e.*, chemical action and mechanical strains. Several methods for overcoming this weakness have been tried, the most noteworthy being the fixing of guttapercha and other flexible cements round the top of zincs where the terminal wire leaves. This prevents the chemical action to a large extent by keeping the junction dry, but does not protect against bending strains.

We illustrate herewith a new and simple method of protection against this last effect. A glance at the woodcuts will explain the principle on which what the makers call the unbreakable terminal zinc rods are made. The rod is slotted in the usual way. The terminal wire is then bent into the form illustrated in outline, and firmly soldered into the slot, the other end of terminal wire being bent into a loop in the usual way. The safety ring prevents the wire making the sudden bend which so soon results in breakage. It is only necessary to take a sample rod and bend the wire backwards and forwards, counting the number of bends before breakage occurs to prove the utility of the invention.

Messrs. Gent and Co., of Leicester, own the patent rights for this simple invention, and are the sole makers, and they stock the rods in six different sizes. We understand that protective compounds are used round the top of the zinc, but this is not shown in the illustration in order that the mechanical construction can be seen.

Telegraphic Jubilee in Belgium.—The 9th of next month will mark the completion of the fiftieth anniversary of the introduction of telegraphy into Belgium, and the Postal Department is preparing to celebrate the event in a suitable fashion. In 1851 the total number of messages transmitted was 19,600 and the receipts £3,520. For the year 1894 the respective figures show a total of over 8,300,000 messages and £140,000.

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SCIENTIFIC EDUCATION.

The rapid advance of scientific knowledge during the last twenty-five years has changed nearly all processes of manufacture. Thus the nation which keeps its workers most to the front in the advance of knowledge gains a great advantage in this competitive age. Germany is fast becoming our most keen competitor in the manufacturing world, and a comparison between their system of scientific education and our own is of great interest. We are, therefore, pleased to give space in our columns to a long letter from Prof. W. Ostwald on this subject. This was addressed to Prof. Ramsay, and deal chiefly with his special subject, which is chemistry. In publishing the letter, Prof. Ramsay says that it shows that "our German competitors are straining every nerve to be first in the field with the enormous changes in chemical manufactures consequent on the application of the electric current to chemical operations. The far-sighted leaders of German industry, it will be seen from Prof. Ostwald's letter, are convinced that progress in pure science is progress in its industrial application, and Prof. Ostwald shows how the training which is deemed requisite and sufficient in Germany is given to students of chemistry. The chief lesson for us English to be learned from this letter is, he thinks, first, what a small part the examinational system plays in German methods of instruction; and, second, what a close bond exists between the man of pure science and the man interested in its industrial application. Our teachers, as well as our leaders in industry, may both with advantage profit by the lesson." On carefully reading the letter in question one cannot but admit that the German system is likely to produce good chemical experts. Also the study of chemistry, and especially of organic chemistry, is one which cannot be adequately given under an examination system. In fact, we think that this branch of science is peculiarly fitted to bring out good results with the German system of education. The close relationship between the scientific teachers of chemistry and the trade that exists in Germany is also found in England. A reference to the life of prominent members of the Iron and Steel Institute, for instance, will show what a large number owe their present position to their early training in chemistry. This knowledge has, however, been obtained at colleges where the examination has not been so strongly in evidence, and where opportunities for original work are provided. The chief difference between the educational systems of the two countries lies in the great difference in the routine adopted. In England the youth intending to follow a technical calling usually commences as a pupil in works at a comparatively early age—say, seventeen. Thus his technical and scientific education is acquired by study of an evening. The great aim of our examination system has been to cheapen the cost of this evening education to the pupil so that a workman's son can afford to attend. This payment by results tends, of course, to restrict the course to the rigid requirements of a syllabus, but with the

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right men as teachers and a practical man as examiner a useful knowledge is given. As a rule, the teachers at these evening classes are also engaged in practical work in the subjects in which they give instruction. As a consequence, the apprentice or pupil can always raise points on subjects on which he finds he wants knowledge in his daily work. The higher technical education is now being provided for by the technical institutes springing up all over the country, where a day course will extend the information previously acquired. In engineering matters, we believe that the simultaneous progress in actual practice and theory is the best way of educating the average youth. In Germany, on the other hand, it is the exception for a man to commence practical work before he is twenty-two, and some take much longer over their education. This system is, as mentioned above, likely to turn out expert chemists, but we doubt that it is as good for the general engineer or for the electrical man. The professors at these schools are, as a rule, chosen because they distinguished themselves when obtaining their degrees, and they then never get into real touch with practical work. The instruction given by these gentlemen tends as a consequence to pure physics, with perhaps special knowledge in one branch, but they do not acquire a general grasp of the everyday practice. In the application of electricity for chemical operations we trust our experts will hold their own, and that the excellent laboratories erected at Birmingham for extending knowledge in this subject may be the first of a series of such equipments to be erected in all our manufacturing towns.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE BRUSSELS INTERNATIONAL EXHIBITION OF 1897.

SIR,—But little attention has been given in this country to the international exhibition that is to be held in Brussels next year, probably for the reason that, until lately, it was wholly a private enterprise. The recent interest taken in the project by the Belgian Government has, however, invested it with considerable importance, and has converted it into an exhibition well worthy of the serious attention of manufacturers and industrials generally. The more important of our foreign competitors have signified their intention of participating in the exhibition: France has already made a grant of £35,000; Germany has appointed a powerful Government commission; in the United States a grant has been made by Congress; and a large number of other countries have accepted the invitation to be present, sent them by the Belgian Government. Our own Government has recently entrusted to an influential British commission, under the presidency of Sir Albert Kaye Rollit, the interests of this country at Brussels; and it now remains for our manufacturers to decide whether they will best consult their own interests by combining to form a representative British court, or whether they can afford to leave the opportunity for extension of business in the hands of our chief rivals—Belgium, Germany, the United States, and France. In urging them most seriously to consider, if not the direct advantages of participation, at least the great danger of abstention, I appreciate fully the cost and inconvenience inseparable from taking part in an exhibition; and if the one to be opened in Brussels next April had remained the offspring of a private company, I do not think it would have been worth the attention of manufactures. But having been adopted by the State, the International Brussels Exhibition of 1897 takes rank among the more important of its kind, and I do not think that this country can afford to be absent or not to be worthily represented there. This a question for exhibitors to determine, and to determine soon, as the time at their disposal is even now restricted. I shall be obliged to intending exhibitors if they will, at their earliest convenience, place themselves in communication with me, in order that I may furnish them with detailed information. I may add that the Brussels Exhibition is universal in its classification, embracing all branches of art, industry, and science.—Yours, etc.,

JAMES DREDGE,
(Executive Commissioner, British Section).

35-36, Bedford-street, Strand, London, W.C.,
August 20, 1896.

THE PLYMOUTH REPORT.

SIR,—If your correspondent who desires knowledge will seek for it under his own name, I shall be pleased to give him the information he needs.—Yours, etc.,

JOHN H. RIDER.

Corporation Electricity Department, East-street,
Plymouth, August 24, 1896.

REVIEWS.

The Gas and Oil Engine. By DUGALD CLERK. Longmans, Green, and Co.

It is 10 years since the first edition of this book was placed before the public under the name "The Gas-Engine." Since then there have been several changes in it as new editions have been required. The most important additions have, however, been reserved till the sixth edition, now before us. The author claims in his preface that additions due to progress have been made rather than alterations in the original, and it is to his credit that such is the case. The parts dealing with oil-engines and with modern gas-engines form the bulk of the new work. In dealing with the various engines on the market or exploited, the author displays the critical knowledge of his subject much wanted in the present day, when so many books of the catalogue type are issued. This differentiating between the advantages of type is of great value both to the student and to the practical man. The large number of reliable tests of both gas and oil engines collected together in this book are interesting reading. Thus, the growth of the efficiency of gas-engines generally is shown by a series of tests on Crossley's engines dating from 1882. At that date a reliable trial showed that an engine took 23·7 cubic feet of gas per indicated horse-power. The London gas used at the trial was of such heating power that the indicated efficiency of the engine was 17 per cent. A Crossley engine of the same size tried by the Society of Arts in 1888 consumed 20·55 cubic feet of gas per indicated horse-power. The indicated efficiency with the particular gas used came out at 21 per cent., a considerable gain over the previous figures. Another trial made by the author in the autumn of 1894 on a 12-b.h.p. engine gave a consumption of 14·5 cubic feet of Openshaw gas per indicated horse-power. The efficiency was then found to be 25 per cent. The author compares the alterations in the engine cycle between these dates, and attributes the rise in efficiency to the increased compression of the charges. This was 38lb. per square inch above the atmospheric pressure in 1882, and rose to 87·5lb. in 1894. He proceeds to discuss the influence of the dimensions of the engine on the efficiency, and the possible increase in efficiencies for all causes. He arrives at the conclusion that in the last test referred to 80 per cent. of the heat available for external work had been used. The author commences the part of the volume devoted to oil-engines by a

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description of the properties of the various types of oil on the market and available for the purpose. This part, which is most interesting to the general reader, is followed by detailed descriptions of 13 different oil-engines. These are fully illustrated, and in many cases tests of the engines are given. The general conclusions on the subject are contained in the last chapter, headed "The Difficulties of Oil-Engines." This contains much expert advice, which will be useful to the electrical engineer when choosing an oil-engine for installation work. The author has a strong objection to electric ignition arrangements, and thinks that the apparatus is likely to get out of order. This method of ignition did good service in the early days of oil-engines, but now can be replaced by recently-improved arrangements for getting incandescent tubes when using heavy oils. The further considerations of vaporising the charge and of engine governing are all treated in a critical but fair way. As a practical treatise for practical men we think this book has no equal.

The Story of Electricity. By JOHN MUNRO. Illustrated. George Newnes, Limited, London. Price 1s.

It would be difficult to find an author better qualified to write a book of a popular character upon electrical matters than Mr. Munro. Not only has he made himself familiar with the history of the subject, but he has also had a large experience in practical work, and, in addition, has a reputation as an author. Thus he knows his subject, knows his audience, and knows how to put his subject to his audience. The result is a very readable, instructive, and interesting little book—of course, almost purely descriptive, but none the less just the kind of book to give the general reader more correct views of the subject than many a pretentious tome.

ELECTRIC LIGHTING IN BELFAST.

We gave in full in our issue of July 31 the paper read by Mr. Victor A. H. McCowen before the Institution of Mechanical Engineers at Belfast. We are now able to give some of the illustrations accompanying this valuable paper. In Figs. 1 and 2 are shown curves of gas consumption, plotted from the results of tests on a tandem and on a single gas-engine; they show the total consumption per hour, per indicated horse-power per hour, and per electrical horse-power hour, and also the percentage of efficiency, or ratio of electrical horse-power to indicated horse-power. The engine of which the test, graphically recorded in Fig. 1, was made is a double-cylinder double-acting one, with the cylinders working tandem and the two pistons on the same rod. This is connected through a cross-head and connecting-rod to the crank. The bore of the back cylinder is 13¾in., and of the front 13½in.; the stroke is 20in. The

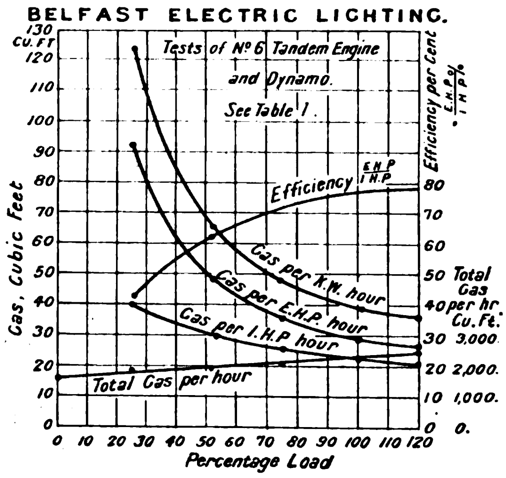

FIG. 1.

flywheel and driving wheel, one fixed on each end of the crankshaft, are each 8ft. 5in. diameter, and weigh 37cwt. and 29cwt. respectively; the driving wheel is grooved for eight ⅞in. ropes. This engine runs at a speed of 160 revolutions per minute and indicates 120 h.p.; the number of explosions per minute is 320, or two per revolution. The smaller engine, to which Fig. 2 applies, is a single-cylinder double-acting

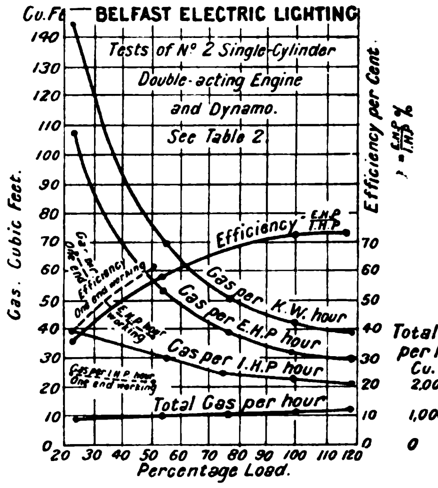

FIG. 2.

one; the cylinder is 13½in. diameter and 20in. stroke. It runs at 160 revolutions per minute, and indicates 60 h.p. The number of explosions per minute is 160, or one per revolution. The flywheel and driving wheel are each 7ft.

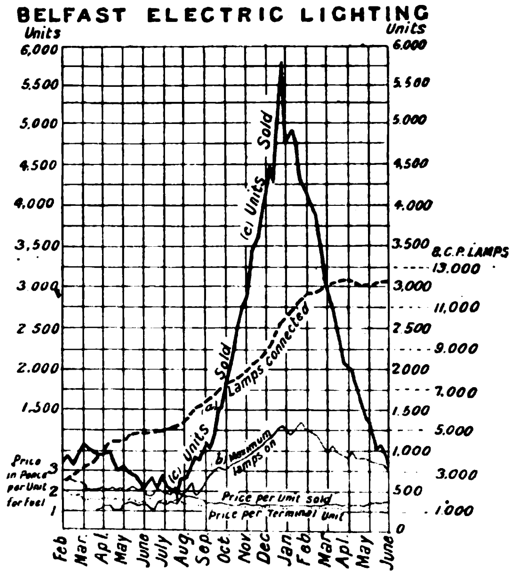

FIG. 3.

diameter, and each weighs 57cwt. The cyclical variation in the speed of the tandem engines is very small, owing to the number of explosions, their low initial pressure, and their even distribution, the number of explosions being as

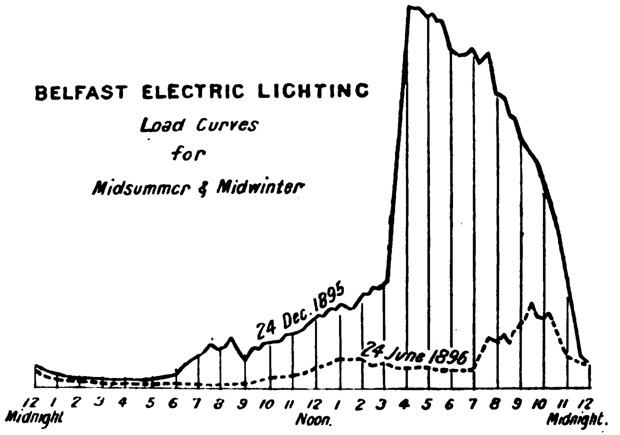

FIG. 4.

four to one in comparison with a single-cylinder single-acting engine. The results shown in these curves were tabulated in the paper, but the graphical record is much easier for reference. These engines, of which four of the

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large size and two small ones are now installed at Belfast, were manufactured by Messrs. Dick, Kerr, and Co., of Kilmarnock.

The other curves deal with the loads on the station at different times. Thus Fig. 3 shows curves for (*a*) number of 8-c.p. lamps connected with the main, (*b*) maximum number of 8-c.p. lamps alight at one time, and (*c*) Board of Trade units sold per week since the station commenced the supply. By comparing curves *a* and *b* it will be seen that the number of lamps alight at one time has never been above 53 per cent. of the lamps connected. Curve *c* shows the great difference between the summer and winter output. The differences between the daily load curves in December and June are well shown in Fig. 4. As shops and offices together form a large percentage of the total consumption, the shape of the load curves depend greatly on their hours of closing. The Saturday curve (Fig. 5)

BELFAST ELECTRIC LIGHTING.

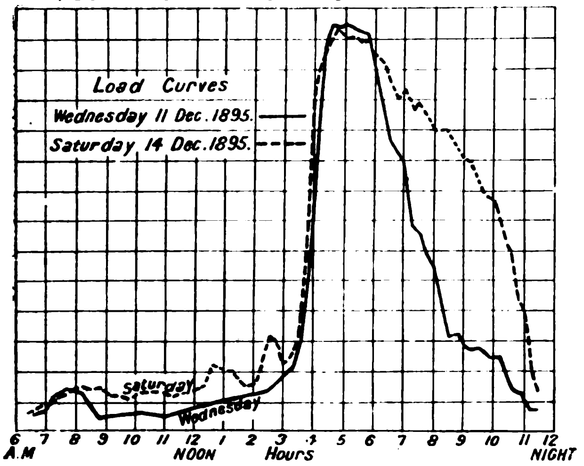

FIG. 5.

shows the effect of the late closing of some shops, a much better load being then given than on Wednesday, and with no very objectionable peak.

NOTES ON THE INTRODUCTION AND DEVELOPMENT OF ROPE DRIVING.*

BY ABRAM COMBE, FALLS FOUNDRY, BELFAST.

Introduction of Rope Driving.—So much has been said and written on the advantages and application of rope driving, and so many data and formulæ have been published from time to time, that it is hardly necessary to add to the information already available in these respects; but as rope driving emanated from Belfast, and has now grown to such large proportions in the industrial transmission of mechanical power, a short history of its origin, introduction, and development may prove of interest on the present occasion. Its introduction is due to the late Mr. James Combe, who in 1856 applied an expanding pulley with V-shaped sides to the differential motion of flax and tow roving frames. The expanding pulley was driven by a round leather rope from a driving pulley grooved with a V-shaped groove. In the course of his experiments in perfecting this motion, he was struck by the large amount of power obtained from round ropes working in V-shaped grooves, and this led him to try their application to the transmission of larger powers. With a view of arriving at the most effective angle for the grooves, a series of experiments were made in the Falls Foundry Works in the following manner: A pulley, fixed from revolving, was made with a number of grooves, each having its sides sloping at a slightly different angle from the others; ropes were then laid over these grooves with weights hanging from them at one end and counterbalance weights at the other; and the effect produced on the biting power of the rope in the groove by increasing and diminishing the weights and the counterbalance weights was carefully noted. The object was to determine in a practical manner the most suitable angle of groove for a driving rope, so that the rope should neither slip nor yet bite too much into the groove; and the angle chosen after the above simple experiments—namely, 45deg.—was adopted in the first pulleys set to work, and is at present generally used for rope driving under ordinary conditions. After several years' use of grooved pulleys and ropes for driving from the main shaft of one of the workshops at the Falls Foundry to that of another, the advantages of rope driving under certain conditions were found to be so great that, on the occasion of replacing one of the main engines in the beginning of 1863, rope driving was adopted for transmitting the entire power of the engine, amounting to over 200 h.p., from the second motion shaft to the principal shaft. This is the first instance of rope driving being used for a main drive of such importance, and the original pulleys are still in existence and working daily.

* Paper read before the Institution of Mechanical Engineers.

Material of Ropes.—About that date round ropes made of leather strips were generally used. These, however, were found to have the objection that they were liable to untwist, and the ends of the leather strips were apt to fly out during the working and cause trouble. Moreover, the strips of leather being cut out of the hide in a spiral were less strong where cut from the smaller diameters, and were liable to break at those parts. Manila ropes were then tried with good results, and leather ropes gradually gave place to ropes made from manila.

Relative Diameters of Ropes and Pulleys.—It was early recognised by the late Mr. James Combe that it is necessary to proportion properly the diameter of the ropes to the diameter of the pulleys on which they work; and he adopted the following minimum diameters of pulleys for the various sizes of ropes:

1¼in. diameter rope,	3ft. diameter pulley;	ratio,	1 to 28·8
1½in. „ „	4ft. „ „	„	1 to 32·0
1¾in. „ „	5ft. „ „	„	1 to 34·3
2in. „ „	6ft. „ „	„	1 to 36·0

Experience has shown that the results have not been so satisfactory when ropes of above sizes have been used on pulleys smaller than the above minimum diameters.

Power Transmitted.—When working under ordinary conditions the following simple bases were taken from which to calculate the power that each of the foregoing sizes of rope would transmit for each 100 revolutions per minute made by the pulley upon which it is working:

Rope 1¼in. diameter	on a 3ft. pulley	5	i.h.p.
„ 1½in. „	„ 4ft. „	8	„
„ 1¾in. „	„ 5ft. „	11	„
„ 2in. „	„ 6ft. „	15	„

and for other sizes of pulleys the power transmitted is calculated to be increased in direct proportion to the diameters of the pulleys. When working under the most advantageous conditions—for instance, where the ropes are running horizontally at good speeds, with the pulleys at a proper distance apart, and with the bottom rope acting as the driver—the above bases may be increased by 20 to 25 per cent. with safety. On the other hand, when the ropes are working under unfavourable conditions, with centres of pulleys too close together or ropes running vertically, these bases must be diminished by 20 to 25 per cent. The exact amount of increase or decrease on these standard bases has to be determined in each individual instance, according to the circumstances under which the ropes are working.

Speed of Ropes.—The speed originally adopted as being the most advantageous was about 3,300ft. per minute. This speed has since been far exceeded in many instances; but it is a question whether advantages have been reaped proportionate to the power gained by the increased speeds. On the contrary, the gain of power by increased speed is largely counteracted by loss of power from atmospheric friction and from centrifugal action; and when this loss is taken into account, along with the increased wear and tear on the ropes and bearings, the speed originally adopted, and speeds within certain limits of it, have been found to give the best results.

Extended Form of Rope Driving.—The new method of driving soon became known to several English and Scotch engineers, who joined in its further introduction and development. An extended form of main rope driving from the second motion shaft to the various lines of shafts in a flax mill is shown in Fig. 1. This drive was started in July, 1864, in the Hilden Mills of Messrs. William

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Barbour and Sons, Lisburn, and is transmitting 600 i.h.p. Another of the earliest examples of rope driving from the flywheel of the engine itself was erected in 1873 at Owen O'Cork Mills, Belfast. This was designed by Messrs. Combe and Barbour, by whom also the pulleys were made, the flywheel being supplied to their instructions by Messrs. Hick, Hargreaves, and Co.

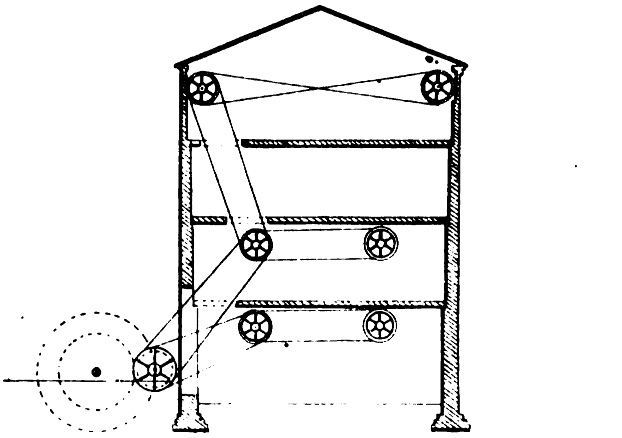

FIG. 1.—Main Rope Drive, 600 i.h.p., Hilden Flax Mills, Lisburn, erected 1864, and still running.

Cotton Ropes.—Later on in certain districts, especially those in which the cotton industry prevailed, cotton ropes began to be used. These have the advantage of being rather more pliable than manila ropes, especially when the latter are new. The relative merits of ropes made of manila and those made of cotton have frequently been discussed; but experience has shown that, if the pulleys are properly designed and applied, and if the ropes are the proper diameter, good results are obtained, whether the ropes are made of manila or of cotton.

Shafts Not Parallel.—One of the great benefits that was found in rope driving at a comparatively early stage was that ropes could be applied with advantage to transmit power between shafts that were not parallel. In 1875 a drive was put up in the works of Messrs. Combe and Barbour to deliver 100 i.h.p. from one shaft to another which was not quite parallel with it. Here the angle between the shafts was about 3deg., and the ropes were applied without making any alteration in the form of the grooves. When, however, it is desired to employ ropes for driving shafts at a greater angle, the grooves in the pulleys are altered to the section shown in Fig. 2, which was introduced about 1875, so as to allow the ropes to enter and leave the grooves without greater friction on their sides than when the shafts are parallel.

Endless Rope for Close Shafts.—In 1878 grooved pulleys and rope driving were introduced to replace pairs of large

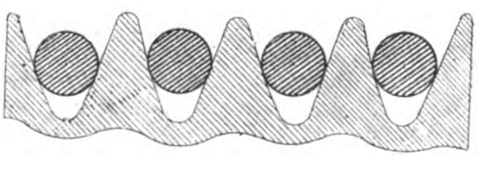

FIG. 2.—Section of Grooves when Shafts are at an Angle above 3deg., date 1875.

geared wheels, which from one cause or another were giving trouble; for example, in places where they were used to combine the power from a steam-engine with that from a waterwheel, or to combine the power from two engines working under slightly different circumstances. Here the centres of the wheels were so close together that ropes, if applied separately in the ordinary way, would have been too short for effective driving, and there would have been difficulty in putting equal tension upon each of the several ropes. Consequently, in order to secure a proper length of rope and equal tension, a single continuous rope was used which was laced round and round the pair of pulleys, passing from the first groove of the driving pulley to the first of the driven, thence back to the second groove of the driving pulley and on again to the second of the driven, and so on; and a tension pulley was added for leading the rope back from the last groove into the first.

Rope Flywheels.—The continued rapid extension of rope driving, and more especially of driving direct from the flywheel of the engine to the various shafts, led to designing flywheels to suit the high speeds. Mr. James Barbour, in 1879, designed a rope flywheel to meet the special requirements. The peculiar advantage of his method of constructing flywheels is that instead of depending solely on a cast-iron arm for connecting each segment to the nave, a strong wrought-iron bolt is used which passes down through the middle of the tubular cast-iron arm, and connects each segment directly with the nave; consequently, this bolt not only receives the tensile strain caused by centrifugal force while the wheel is in motion, but it also withstands the driving home of the cotters when the wheel is being put together. When cast iron alone is used for the arms, the driving home of cotters is a frequent source of breakage, which may not be detected until the flywheel gives way, whereas by driving the cotters into a long malleable-iron bolt there is less danger of fracture.

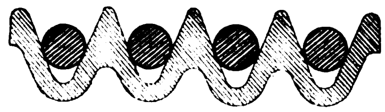

FIG. 3.—Section of Grooves for Curved Rope Drive, 1879.

Crossed Ropes.—It was about the same date that driving by crossed and half-crossed ropes was introduced; also that rope driving was applied to shafts working at right angles to each other, round corners, etc.

A special form of groove has to be used for cross-rope driving, so that each rope, though of necessity rubbing on itself, does not rub against its neighbours. The grooves are shown in the section, Fig. 3. They are constructed so that their pitch is greater than twice the diameter of the rope, as a further means of preventing the ropes from rubbing against their neighbours.

Endless Rope with Loose Guide-Pulleys.—In 1889 the arrangement of rope driving shown in Fig. 4 was introduced by Mr. James Barbour. Here the driving and the driven shafts were near together, and there was not sufficient space to apply the tension pulley previously described. A single continuous rope was therefore laced round the grooves of the pulleys, and for the purpose of leading the rope back from the last groove of the one pulley into the

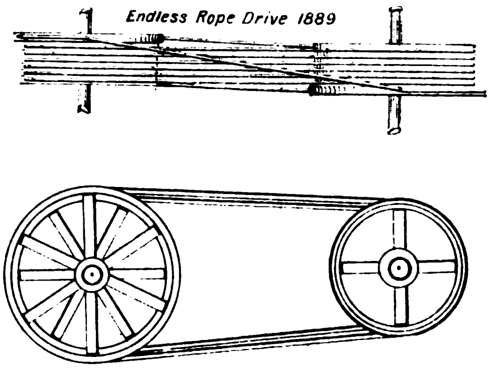

FIG. 4.

first groove of the other an additional single-grooved pulley was mounted loose on each shaft; these two loose pulleys were made larger in diameter than the fixed pulleys, and the rope was led from one to the other over the top of the ropes working in the grooves of the fixed pulleys. A large number of drives have been erected in this way, and all are working satisfactorily.

Endless Rope Driving Several Pulleys.—About the same date also a drive was erected, in which a single continuous rope was used for driving from one common pulley several shafts running at different speeds. In Fig. 5 is shown an example of one of these drives, in which a tension pulley is used to bring the rope back from the last groove into the first, and at the same time to take up the slack of the rope. In 1890 Mr. Barbour further developed the use of the single continuous rope, by applying it to the half-cross drive, in which by the peculiar method of lacing a single

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endless rope is passed round the several grooves in succession, and back from the last groove to the first, without the intervention of a guide or tension pulley.

Substitution of Rope Driving for Geared Wheels and Relative Amount of Power Absorbed.—In many instances existing gearing and upright shafts have been thrown out and replaced by rope driving; and where the rope driving has been properly designed and erected, the total power required for the rope driving has in none of the installations which have come under the writer's observation exceeded that which was required when driving by wheel gearing; and in many cases the power required to drive the same amount of work by ropes has been less than it was before the change in method of driving took place.

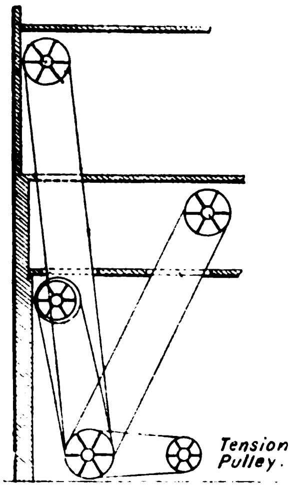

FIG. 5.—Single Endless Rope driving several Pulleys from One Common Pulley, 1889.

The above examples of the transmission of mechanical power by ropes serve to illustrate the development of this method of driving. Numerous variations have, of course, been made upon each of these plans, which have largely extended the field for the application of rope driving; so that this method of driving, which arose from such a small origin, is now widely adopted for industrial purposes. There is also no doubt that other developments will take place in the future, which will further extend its sphere of usefulness.

ON THE PROPER USE OF SAFETY FUSES AND MAGNETIC CIRCUIT BREAKERS.

BY WM. BAXTER, JUN.

In the days when electricity was truly in its infancy, one of the first facts discovered by those who were engaged in the actual operation of dynamos was, that some means must be provided for opening the circuit whenever the current strength rose beyond a certain limit. Two methods suggested themselves for accomplishing this result—the blow-out fuse and the magnetic cut-out.

The fuse became the most popular, owing principally to its cheapness and extreme simplicity. Notwithstanding all the good things that may be said of the fuse for past services, it is a crude device, and should only be used in what may be termed its own sphere of usefulness. This sphere is for the protection of branch circuits.

In a lighting plant all the branches may be protected by fuses, but in the main circuit they are of little, if any value, owing to the fact that their carrying capacity must be considerably above the normal current to avoid blowing out with such frequency as to be annoying. In branch circuits, if a fuse is used that will give way with a current of double the normal capacity, it will afford all the protection necessary, providing the wiring is of such proportions as to keep the line loss within reasonable limits. But if a fuse of similar proportions were used to protect a generator, it would be of no value. If the load on a generator is very uniform, a fuse may be used that is nearer to the normal current than two to one; but even under the most favourable conditions, if the margin is made less than 50 per cent., the frequency with which the fuse will blow out will be greater than would be admissible in most cases. Considering the foregoing facts, it is evident that a fuse placed in the main circuit of a generator will afford very little protection.

A question that has been agitating the minds of quite a number of central-station managers of late, and one which is worthy of very careful consideration, is whether it is advisable to use station safety cut-outs of any kind? Those who advocate discarding them claim that the occasional discontinuance of the current, when these devices act, causes dissatisfaction among the customers, and that it is better to suffer the loss caused by a burnt out armature now and then to loss of prestige in consequence of unsatisfactory service. There is a great deal of truth in this, and no doubt the desire to guard against loss occasioned by burn-outs due to excessive current is a relic of the days when economy of operation was considered of more importance than efficient service.

The use of safety devices may be entirely discarded in central stations without incurring the danger of burn-outs, if the capacity of engines and generators is in proper proportion. In cases where a number of machines are operated by a single engine, each one supplying an independent circuit, safety devices may be used, and the conditions may be made such that the cut-outs will very seldom come into action. To illustrate the truth of these statements, take the case of an engine driving a number of generators in parallel. All the safeguard necessary may be obtained by making the power of the engine less than the combined capacity of the generators, and providing each of the latter with an effective device for maintaining a constant E.M.F.

The common practice has generally been to have the engines of ample capacity to do the work; this, when properly interpreted, means that they should be of sufficient power to drive the generators at their maximum output, and still have a margin left for an emergency. But it is these emergencies that are fatal to the generator, and to provide the engine with a reserve capacity to meet them amounts to providing means for burning out armatures whenever the circuit becomes overloaded. If the steam-engine is overloaded, it will suffer no injury; the most that can happen will be that the speed will reduce, and if the overload is sufficient, the engine may be brought to a standstill. The generator is quite different, however, and, like the faithful horse, will work until it drops dead.

It may be said that even if the combined capacity of the generators is greater than that of the engine, there will still be danger of a burn-out, because the current in any one machine may rise above the average. This would be true, providing no provision were made to prevent such contingencies. Generally, generators coupled in parallel are connected by an equalising wire, which, while not able to maintain a perfect uniformity, tends to keep the difference in current so low as to be within the safe limit. Still greater certainty could be obtained by providing each generator with an automatic switch that would vary the resistance in the shunt circuit in accordance with variations in the strength of current passing through the armature.

If the generators are not connected in parallel, but are used to supply independent circuits, there will be little or no danger of burn-outs if the capacity of the machines is greater than the demands of the circuits they supply, and this danger can be made still less by using cut-outs set to act at a point just below the safe limit.

Where each generator is driven by an independent engine all danger of burn-outs from excessive current can be removed by this simple expedient of increasing the capacity of the generator. If you consult an engine-builder he will say that to drive a 100-kilowatt generator an engine of at least 175 h.p. should be used, and that 200 h.p. would be better. This advice he gives, because from his experience he believes that the generator would be forced beyond 100 kilowatts so far as to prevent good regulation with a smaller engine. Now if you instal a 100-kilowatt generator with a 200-h.p. engine, and then begin to overload the current, the generator will surely get into trouble before the engine begins to feel the strain. If you consult the generator manufacturer as to the size of engine, he will probably say that 150 h.p. is ample, but

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even this is too much, if perfect safety is desired. To guard effectually against burn-outs, the proper plan to pursue is to ascertain the demand of the circuit, either actual or estimated, then provide engine capacity sufficient to meet this, making a fair allowance for loss in the generator, and a margin for abnormal demands. Then provide a generator that when working within the limit guaranteed by the makers will absorb the maximum power of the engine.

From the foregoing it will be seen that cut-outs and blow-out fuses in the main circuits of central stations and isolated plants are not necessary, and that all the protection they can possibly afford can be obtained by simply enlarging the capacity of the generators.

The only proper place for blow-out fuses is in branch circuits, and then they are necessary to prevent overheating the wires in case the current should become abnormally large from any cause.

Fuses are very generally used to protect motors, but for that purpose they are of very little value. A magnetic cut-out is the only proper safeguard for a motor, and to be of real value it should operate either with an excessive current or no current at all. It is not an uncommon thing for the current through a motor to be interrupted, and in such cases, if the switch is not opened, serious damage may be done when the current is established again. If the cut-out works both ways, mishaps in most cases will be avoided because as soon as the current stops the circuit will be opened.

There are cut-out switches of this kind on the market, and judging from their general appearance, they should be effective, but few of them are in actual use. The fuse is the mainstay and also the source of no small amount of annoyance, owing to the fact that it can be easily blown in the act of starting the motor if the attendant is inexperienced. Whenever they blow out there is more or less delay in inserting a new one, and also an expense which, although small, runs up to an appreciable amount by the end of the year. Owing to this annoyance and expense, the size of the fuse is increased in many cases to a point where it is simply no protection whatever, as it can carry more current than the motor. If cut-outs were used, they would be set to act nearer to the working capacity than is the case with fuses, because if they should act, they could be reset in a few seconds by the simple movement of the lever.—*Electrical Engineer* (New York).

ALTERNATE-CURRENT MOTORS.

We referred in our issue of the 7th inst. to some motor tests by Prof. D. C. Jackson, which were the subject of a paper read before the North-Western Electrical Association of America. We are now able to give the curves and table of efficiencies, etc., as promised then. The chief fault with the arrangements is that the type of the different motors tested is not given with the test figures. Thus, the eight m tors included the following types and makes, and we can only assume that they are given in the order listed: A Fort Wayne Electric Corporation single-phase motor, a Stanley Electric Manufacturing Company two-phase motor, a Westinghouse Electric and Manufacturing Company two-phase motor, a General Electric Company three-phase motor. A 5-h.p. three-phase motor made by the Allgemeine Electricitäts Gesellschaft of Germany was also tested, and the results of tests on motors made at Oerlikon and at Brown and Boveri's works are included in the tables. A 10-h.p. Westinghouse two-phase motor was tested, but not up to its maximum load. Five-h.p. motors were selected to be tested, as that may be considered to be near the average capacity of motors used in the service of ordinary central stations. Prof. Jackson thinks that the results of the tests may, therefore, be accepted as representing, for the central stations, comparative results between the average motors which they may use on alternating-current systems. The results may also serve as a basis for comparison between average conditions of operating with continuous-current and alternating-current motors. Four out of the six motors tested are said to have affected the incandescent service disastrously, and showed the absurdity of attempting with them a combined service on

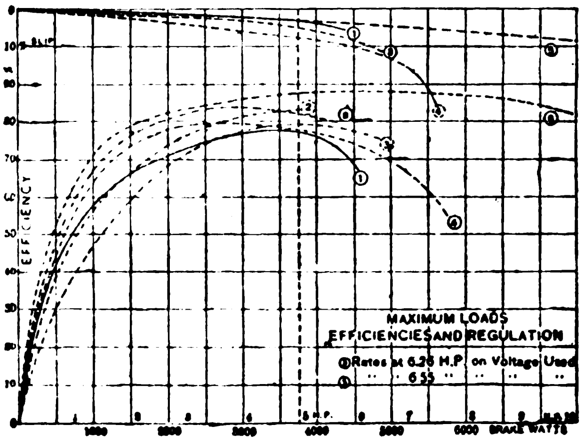

Diagram of Efficiencies and Power Factors.

the same circuits as the incandescent lighting in those plants where regulation and the satisfaction of the customers is considered of importance. The tests show, according to Prof. Jackson, that the alternating current motors give equally satisfactory regulation and efficiency as is given by continuous-current motors, but the power factors of most of the machines are small for part load, the starting currents excessive, and the starting torques with the present arrangement of starting resistances are unduly small. The best performance of the American 5-h.p. machines lies between No. 3 and No. 5 of the tables. These machines stand well above the others. They are about even in starting torque, but No. 5 will carry considerably higher torque before dropping out of step completely; No. 5 also regulates the better and has the higher efficiency. On the other hand, No. 3 has a power factor incomparably better than any of the other machines.

As mentioned above our chief objection to the arrangement of the table is that due to the confusion of types. Single-phase motors are never so efficient as two or three-phase motors of the same output, and hence it is misleading to compare them directly. Again, when the alternating system has been established on the single-phase system the type of motor is fixed, and hence the figures for multiphase work do not apply. We also regret that the frequency at which the different tests were made is not listed.

Number.	Rated capacity, h.p.	Rating at voltage used, h.p.	Torque, in Per Cent of Full Load.			Starting current, in per cent. of full load.	Drop in speed at full load, per cent.	Efficiencies, Per Cent.					Power Factors, Per Cent.					
			Max. running.	Static.	Starting.			Max. eff.	Quarter load.	Half load.	Three-quarter load.	Full load.	Max. p. f.	No load.	Quarter load.	Half load.	Three-quarter load.	Full load.
1 ...	5	5	140	131	77	157	3	77·8	55·2	70 6	77	76 6	76·4	13	37·5	50	62·3	71 5
2 ...	5	5	100	45	44	153	—	83 8	54·5	72 5	80·5	83·8	67 5	10·5	25 5	58	67·3	64
3 ..	5	6·26	104	90	83	114	9·7	79	52	71 9	78·9	77	84	74	81·6	83·3	83 7	84
4 ..	5	5	186·5	136	39 4	262	7	79·5	62·2	77·2	79 5	77 8	82 6	15·5	44·7	62·5	73·7	80 3
5 ...	5	6·55	171	138·5	86 6	156	3·7	88	75·2	85	87·7	88	78·5	6·8	27·5	45·5	59 8	70·3
6 ..	10	10	147	142	137	194	4·5	82	67	78·4	81·9	81·1	79	15	40·4	59·1	69	73·4
7 ..	4·5	4·5	163	232	—	357	3·7	79·1	61	73·8	78·4	79·1	88·4	22·2	51 3	69·4	80 3	85·2
8 ...	5	5	—	—	—	—	4·6	83·8	65 5	80·2	83 8	82	89	--	52	71·5	81 7	87 2

Note.—Nos, 6, 7, and 8 were not run up to maximum load, on test.

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SCIENTIFIC EDUCATION IN GERMANY AND ENGLAND.

BY PROF. W. OSTWALD

In our frequent discussions on scientific education, we have both often been struck with some points of very great difference between the English and the German way of dealing with it. As it may be asserted without national arrogance that university education is in Germany in a more satisfactory condition than in your country, you are, of course, anxious to know which of the German customs I consider most effective in bringing about this better state of things, and I will, therefore, try to point them out. Of course, I shall confine myself to the subject of natural science, and especially chemistry and physics, feeling myself unable to deal with sciences beyond my knowledge. The main point of our system may be expressed in one word—freedom—freedom of teaching and freedom of learning. The first involves for the teacher the necessity of forming in his mind a clear conception of the scope of his science, for, as he is free to choose any possible method of view, he feels himself answerable for the particular one he has chosen. And in the same way the student feels himself responsible for the method and the subjects of his studies, inasmuch as he is free to choose any teacher and any subject. One who has not seen this system in action may be inclined to think that such a system must lead to arbitrary and irresponsible methods on the side of the teacher, and to confusion on the part of the student. But the former is avoided, because at the beginning of his career the teacher is dependent for his advancement on the results of his scientific views, and is naturally anxious to improve his position in the educational world. And as for the students, they themselves impose certain restrictions on their own freedom. Most of them feel that they require some advice and guidance, and they therefore follow the usual and approved order in conducting their studies. As to the inventive man of original ideas, it has often been proved that for him any way is almost as good as any other, for he is sure to do his best anywhere. Moreover, such a man very soon excites the interest of one of his teachers and is personally led by him, generally to the great advantage of both.

Let us illustrate these general remarks by considering the course followed by an average chemist. In his first half-year he hears lectures on inorganic chemistry, physics, mineralogy, sometimes botany, and of late often differential calculus. Moreover, the German student is accustomed to take a more or less strong interest in general philosophy or history, and to add in his *Belegbuch* (list of lectures) to the above-named *Fachcollegien* (specialised studies) one or two lectures on philosophy, general or German history, or the like. Very often there are in the university one or more popular professors whose lectures are heard by students of all faculties without reference to their special studies. The student who has heard during his stay at the university only lectures belonging strictly to his *Fach* is not well thought of, and is to some extent looked down on as a narrow specialist. But I must add that such views are not prevalent in all faculties, and there are some—*e.g.*, the faculty of law—whose students confine themselves, with few exceptions, to attending exclusively lectures in that faculty.

In the second half-year the chemical student begins with practical laboratory work. Notwithstanding the perfect freedom of the teachers, the system first introduced by Liebig into his laboratory at Giessen is still universally adopted in German universities and technical high schools—viz., qualitative and quantitative chemical analysis, the former conjoined with simple spectroscopic work, the latter amplified by volumetric analysis. This is followed by a course of chemical preparations, formerly chiefly inorganic, now chiefly organic. Even here, a regular system is being widely developed owing to the use of some well-known text-books. Of late years this course is followed in some laboratories by a series of exercises in physical chemistry and electro-chemistry.

While these practical exercises, which last for three or four half-years, are being carried out, the student completes his knowledge of physics, mathematics, and the other allied sciences by hearing lectures and working practically in the physical and often also in some other laboratory. The exercises done, he goes to the professor and asks him for a "theme" to begin his "work"—viz., his dissertation for the degree of Dr.Phil. This is the most important moment in his life as a student, for it generally determines the special line of his future career. The "theme" is usually taken from the particular branch of the subject at which the professor himself is working; but, as the scientific name and position of the professor depends, not only on his own work, but to a large extent on the work issuing from his laboratory, he is careful not to limit himself to too narrow a range of his science.

Of course, it is best of all if the student selects for himself a suitable "theme," suggested to him by his lectures or practical work, or from private study of the literature of the science. But this seldom happens, for the young student is not yet able to discern the bearing of special questions, and lacks knowledge how to work them out. Sometimes (but not very often indeed) he points out to his professor in a general way the kind of problems he would like to work at, and the professor suggests to him a special problem out of this range of subjects. During the working out of his chosen subject the student learns generally much more than he has heard at lectures. Every part of the investigation forces him to revise the scientific foundations of the operations he performs. During this time the incidental short lectures given by the professor on his daily round from one to another of the advanced students are most effective in deepening and strengthening the student's knowledge. As these explanatory remarks are generally heard not only by the student whose work has caused them, but also by a number of fellow students working near, a fairly wide range of scientific questions are dealt with in their hearing. Often these small lectures develop themselves into discussions, and, as for myself, I judge from the frequency of such discussions between the students whether the session will turn out a good one or not. If the professor thinks the work sufficiently complete to be used as a dissertation, the student proceeds to the close of his studies. He prepares himself for the examination, which is conducted by the very professors whose lectures he has heard, and in whose laboratories he has worked. This examination varies somewhat in different universities, but in no case is it either very long or extensive; indeed, it is not considered as very important, for we are all aware what an uncertain means of determining a man's knowledge and capabilities and examination is, and how much its issue depends upon accidental circumstances. Part of this uncertainty is removed by the fact that the professor and the pupil know each other, are acquainted with one another's modes of expression and scientific views. The main purpose of the examination is to induce the student to widen his knowledge to a greater extent than is covered by the subject of his dissertation; but, indeed, it happens very seldom that a student whose work is considered sufficient does not pass the examination.

We have no great fear that this system may induce a professor to treat his own pupils in too lenient a way, and so lower the standard of the doctor's degree. There was a time when such abuses used to occur, but there very soon arose such public indignation that the abuses ceased to occur. Even at the present day similar instances occasionally occur, but, as before remarked, the position of a professor depends in such a degree upon the value of the dissertations worked out under his supervision that such deviations from the right way correct themselves in the course of time. The most effective instrument for that purpose is the publication of all dissertations and the consequent public control over them; for this reason publication is, I believe, compulsorily prescribed in all German universities.

When the student has finished his course he is still entirely free to choose between a scientific and a technical career. This is a very important point in our educational system; it is made possible by the circumstance that the occupation of a technical chemist in works is very often almost as scientific in its character as in a university laboratory. This is connected with a remarkable feature in the development of technical chemistry in Germany—the very point upon which the important position of chemical manufacture in this country depends. The organisation of the power of invention in manufactures, and on a large scale, is, as far as I know, unique in the world's history, and it is the very marrow of our splendid development. Each large work has the greater part of its scientific staff—and there are often more than 100 *doctores phil.* in a single manufactory—occupied, not in the management of the manufacture, but in making inventions. The research laboratory in such a work is only different from one in a university by its being more splendidly and sumptuously fitted than the latter. I have heard from the business managers of such works that they have not unfrequently men who have worked for four years without practical success; but if they know them to possess ability they keep them notwithstanding, and in most cases with ultimate success sufficient to pay the expenses of the former resultless years.

It seems to me a point of the greatest importance that the conviction of the practical usefulness of a theoretical or purely scientific training is fully understood in Germany by the leaders of great manufactories. When, some years ago, I had occasion to preside at a meeting, consisting of about two-thirds practical men and one-third teachers, I was much surprised to observe the unhesitating belief of the former in the usefulness of entirely theoretical investigations. And I know a case where, quite recently, an "extraordinary" professor of a university has been offered a very large salary to induce him to enter a works only for the purpose of undertaking researches regarding the practical use of some scientific methods which he had been working at with considerable success. No special instructions are given to him, for it is taken for granted that he himself will find the most promising methods; only, in order to increase his interest in the business, part of his remuneration has been made proportional to the commercial success of his future

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inventions. From this clear understanding of the commercial importance of science by the directors of industrial establishments there science itself gains another advantage. A scientific man can be almost sure, if he wants in his investigations the help of such technical means as only great works can afford, that he will get such assistance at once on application to any work; and the scientific papers of German chemists very often contain acknowledgments, with due thanks, of considerable help they have thus obtained.

Besides these advantages for the development of scientific and technical chemistry in Germany there exists another very important factor—practical assistance from the Government. Universities are in Germany affairs of the State, not of the Empire, and in no other point has the division of the Fatherland into many smaller countries proved itself to such a degree a boon and a blessing. The essential character of the German universities, the freedom conferred by the independence of the numerous universities, is never lost. There have been hard times occasionally for the universities of one country or another; but some universities were always to be found where even in times of hard oppression liberty of teaching and learning remained complete and unaffected, and the spirit of pure unalloyed scientific research was preserved and encouraged. So this palladium of intellectual freedom has never been lost; and it regained the former influence as soon as the casual oppression ceased. In our days there is among all the separate State governments in Germany a clear conviction of the importance of practical support being given to pure scientific research. To take one instance, in order to facilitate teaching and research in electro-chemistry—a recently developed branch of science—a suggestion by some leading practical scientific men to the members of the Government was sufficient. Upon such a suggestion a considerable sum of money was spent first by the Prussian Government for the endowment of electro-chemical chairs and laboratories in the three "polytechnic" colleges of that country; a short time afterwards it was resolved to erect at one of the universities, Gottingen, an institute for physical chemistry, and especially electro-chemistry, in the shape of a building which has just been completed. At the same time other German countries have begun to grant to their universities and technical colleges considerable sums of money for similar purposes—*e.g.*, the Saxon Landtag alone has unanimously voted half a million marks (= £25,000) for the erection of a splendid laboratory for physical chemistry at Leipzig.

You will excuse my boasting about our German management of this most important question of scientific education. It is no blind admiration without criticism, for I know by practical experience the management in other countries, and I can compare them. And it is only for the sake of science itself that I write these lines. If they should help the spread of the conviction of the incomparable practical usefulness of every support given to pure science, together with the recognition of the fact that the latter can only grow in an atmosphere of liberty and confidence, I should regard it as tending towards the progress of science itself and destined to exercise such an influence on scientific progress as may be compared with the discovery of the most remarkable scientific fact.

The foregoing is a letter written by Prof. Ostwald, the founder and editor of the *Journal of Physical Chemistry*, to Prof. W. Ramsay, of University College, and inserted by him in the *Times*.

LEGAL INTELLIGENCE.

A THREAT TO CUT TELEPHONE WIRES.

In the High Court of Justice, Chancery Division, on August 26, the case of the National Telephone Company, Limited, *v.* Armand was heard before Mr. Justice Chitty.

This was a motion by the plaintiff company for an interim injunction to restrain the defendant, until the trial of the action or further order, from using or communicating in breach of confidence, and to the detriment of the plaintiffs, any information obtained by him while in their service, and also from cutting, destroying, or damaging any telephone wires or posts of the company.

Mr. Baker, who, with Mr. Heckscher, appeared in support of the motion, stated that the defendant had been employed by the company as wayleave officer, his business being to obtain permissions for carrying their wires over private property, and had acted in that capacity for something over 12 months. The district superintendent, on July 23, gave the defendant notice terminating his engagement on the 30th, and thereupon he wrote to the general manager asking that the matter might be looked into Though the general manager had refused to interfere with the action of the district superintendent, the defendant was offered a berth as canvasser at a salary of 25s. a week, but this he refused to accept, and in his letter to the general manager intimated that if the decision was not reconsidered he should assume an attitude of bitter antagonism to the company. Since then he had threatened to cut down the wires unless a certain rent was paid for the wayleave he had obtained for overhead wires.

The **Defendant** appeared in person, and, in answer to his Lordship, before the case for the plaintiffs was opened, said he had no evidence to put upon affidavit.

Mr. Justice Chitty: I must grant an injunction. The plaintiffs will give an undertaking in damages, and there will be the usual order. I warned the defendant before the case was opened of the position in which he would find himself if he gave no evidence. The case is really undefended, and the inference to be drawn is that the information was obtained by the defendant in the manner suggested by the plaintiffs. The plaintiffs' costs will be costs in the action.

COMPANIES' MEETINGS.

BRUNNER, MOND, AND CO., LIMITED.

The half-yearly meeting of Brunner, Mond, and Co., Limited, was held in Liverpool on August 20, Sir John T. Brunner, M.P., presiding.

The **Chairman** moved the adoption of the report, showing a total profit for the half-year of £276,031, and proposing to pay a 7 per cent. dividend on the preference shares and 30 per cent. on the ordinary, and carrying forward £96,544, after placing £18,658 to reserve and £500 to patents accounts, and it was agreed to.

A subsequent extraordinary meeting was held to deal with a special resolution for increasing the capital from £2,000,000 to £3,000,000 by the creation of new stock, and to make contracts with any of the directors for occasional services, and to make yearly balance-sheets in future, etc.

The **Chairman**, in moving the resolution, said that increasing the capital from £2,000,000 to £3,000,000 seemed rather a big jump, but if the 7,906 preference shares were taken up, the £2 000,000 would be fully exhausted, and it was only paying a little sooner than otherwise the £1 per thousand of duty to the State. As to the proposal to issue yearly balance-sheets, it was found that taking stock twice a year was putting such a strain upon the staff that they thought it ought not to be done. An interim dividend would, however, be paid.

The proposals were unanimously adopted.

ELECTRIC CONSTRUCTION COMPANY, LIMITED.

The third annual general meeting was held at Winchester House yesterday (Thursday), Sir Daniel Cooper, Bart., in the chair.

The **Chairman**, in moving the adoption of the report and accounts, which were published in our issue of August 7, pointed out that the net profit for the year amounted to £16,450, and adding to this £10,135 carried over from last year, the amount available for dividend was £26,585, of which the directors recommended that £13,288 be paid in dividend of 5 per cent.

The report was adopted, and the retiring directors re-elected.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Paris.—Tenders are wanted by September 8 for the supply of magneto-electric calls for the Departments of Posts and Telegraphs, rue de Grenelle 103, Paris.

Dantzig.—Tenders are wanted for the supply of incandescent lamps and carbons. Particulars for 75 pf. (9d.) from the Konigliche Direction der Gewehrfabrik, Dantzig.

Dortmund (Germany).—The Municipal Authorities of Dortmund want tenders by September 1 for engines, boilers, and dynamos for the electric lighting of the town.

Spa (Belgium)—The Burgomaster and Echevins of Spa invite propositions for undertaking the public lighting, either electrically or by acetylene. The date fixed is September 15. No further information is given in the official advertisement.

Villefranche-Lauragais (France).—The Municipality of Villefranche-Lauragais (Haute-Garonne) have invited competitive plans for a public water supply and electric lighting. Prizes of 1,000fr., 500fr., and 200fr. are offered, under the usual conditions, and schemes must be sent to the Mairie by October 10.

Cologne.—Tenders are required by the Municipal Authorities for the construction and working of electric tramways in the city of Cologne to an aggregate length of 20·3 kilometres (12½ miles). Specifications, plans, and particulars are obtainable for 10 marks (10s.) from der Registrateur B, des Oberbürgermeisteramt, Köln, Germany, and tenders must be in by November 6.

Madras.—Tenders are invited for the lighting by electricity of Government House, Madras, including the banqueting-hall and aide-de-camps' bungalow, and also for the lighting of Government House, Guindy, including the military secretary's bungalow. For particulars application must be made to the consulting architect to the Government, Chepank, Madras. Tenders will be opened on November 11, 1896.

Voghera (Italy).—In view of the expiration of their contract with the local gas company in 1898, the municipal authorities of Voghera are desirous of receiving during the present year propositions for the lighting of the town either by the electric light or a mixed system of gas and electricity. The population is 16,000. Application should be made to L'Administrazione Comunale, Voghera, who will give all particulars necessary.

The Hague.—The Consul-General of the South African Republic demands tenders for the supply of copper wire for the Telegraph

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Department of the South African Republic. Tenders which have not been received before September 1, Doelenstrat, No. 8, at Amsterdam, will not be regarded. Specifications will be procured on demand by F. J. Belinfante, late A. D. Schinkel, Paveljoensgracht, The Hague, Holland, at the price of 1sh. pro tender.

Mayaguez (Puerto Rico).—The Secretary of State for Foreign Affairs has been informed by H.M. Ambassador at Madrid that the Spanish Government have invited tenders for the construction and working of a telephone system in Mayagüez, Puerto Rico. The date fixed for the consideration of tenders is October 8, and such particulars as have been received may be inspected at the Commercial Department of the Foreign Office between the hours of 11 and 6 daily.

Oldham.—The Electric Light Committee invite tenders for the various works required in the extension and alterations of the buildings of the electric light station in Gas-street, Oldham. Specifications and drawings can be seen, and schedules of quantities obtained, on application to Mr. Arthur Andrew, Gas and Water Offices, Oldham. A charge of £1. 1s. will be made for the schedule of quantities, which will be returned on receipt of a bona fide tender. Tenders to be sent in by September 15.

Hull.—Pending the decision of the Town Council as to the leasing of the tramways or the working of them by the Corporation, tenders are invited for a license to temporarily work and use the tramways for one year from October 15, 1896, upon the terms and conditions embodied in the draft of an agreement, which can be obtained by application to Mr. R. Hill Dawe, town clerk, Town Hall, Hull. Tenders, stating the amount of rent offered, must be delivered at the Town Clerk's Office, by 10 a.m. on September 21, in sealed envelopes, endorsed "Tender for Temporary Working of Tramways."

Bristol.—The Electrical Committee require tenders for additions to the electric lighting station, Temple Back. The plans may be seen, and copies of the specifications, forms of tender, and bills of quantities may be seen and obtained at the office of the architect, Mr. Henry Williams, 24, Clare-street, Bristol, on payment of £3. 3s., which will be returned on delivery of a bona fide tender. Tenders must be delivered by noon on September 4, addressed to the Secretary, Electrical Department, Temple Back, Bristol, and endorsed "Tenders for Additions to Central Station."

Southampton.—The Harbour Board invite tenders for the construction and erection of four electric cranes and accessories, and also for alterations to a gantry of an existing crane, on the Town Quay, Southampton. Specification, with two general drawings attached, may be obtained on and after 20th inst. from Mr. A. H. Skelton, clerk, Town Quay, Southampton, upon payment of £3. 3s., which will not be returned, and further detailed plans may be seen at the office of the electrical engineer, Mr. J. G. W. Aldridge, 9, Victoria-street, Westminster, S.W. Sealed tenders, marked "Tenders for Electric Cranes," should be sent to the clerk by August 31.

Blackpool.—The Corporation are prepared to receive tenders for the supply, laying, and maintenance of high-tension and low-tension lead-covered cables and the supply of all necessary jointing sundries. Specifications and bills of quantities, together with forms of tender, may be obtained from the Borough Electrical Engineer, on payment of 10s. 6d., which will be returned on receipt of a bona fide tender. Tenders, addressed to the Chairman of the Electric Lighting and Tramways Committee, and endorsed "Tender for Cable," should reach the offices of Mr. Robt. C. Quin, borough electrical engineer, Corporation Electricity Works, Blackpool, not later than September 8.

Jassy.—The Mayoralty of the Town of Jassy (Roumania) has given notice that on August 23, 1896, old style (by our reckoning September 4), tenders will be received, for the second time, in the hall of the Municipal Council, for "the installation of a frigorific hall, electric light, and various accessories requisite for new public slaughter-houses. Offers must be in accordance with the specification, the conditions of contract, the special conditions, and the plans deposited in the offices of the director of the slaughter-house works, where particulars may be obtained." Tenders are to be enclosed in sealed envelopes, marked "Offre pour l'installation de la Hall Frigorifique," and senders of tenders must abide by articles 68-79 of the Roumanian Public Accounts Act. All tenders and supplementary documents must be in either the Roumanian or French language.

Cadiz.—The Secretary of State for Foreign Affairs has received dispatches from her Majesty's Consul at Cadiz, stating that preliminary tenders for a supply of electric lighting apparatus for the illumination, on the most approved modern plan, of private houses, etc., in the town of Cadiz are invited by the "Sociedad Co-operativa Gaditana de Fabricacion de Gas." It appears that the tenders should be sent in by September 15 to the above-named company, whose offices are San José, 25, 27, and 29, Cadiz. Firms wishing to obtain the contract for the supply of plant are advised by the Consul to send representatives to treat personally with the company. Such additional particulars as have reached her Majesty's Government on the subject may be viewed at the Commercial Department of the Foreign Office, any day between the hours of 11 a.m. and 6 p.m.

Bath.—The Corporation invite tenders for the supply and erection of the following plant:—Section A: Boiler and fittings, feed pump, etc. Section B: Steam alternators, oil-filter, fittings, etc., steam, exhaust, feed, blow-off, and sundry pipes, valves, etc. Section C: Mains. Section D: Crane. Section E: Arc lamps and posts. Tenderers are at liberty to tender for either section, but not for part of a section. The ground plan of plant and specification, with terms and conditions of tender and contract, may be obtained at the office of Mr. Robert Hammond, the consulting engineer, Ormond House, Great Trinity-lane, E.C., on and after the 13th inst., on payment of £2. 2s., which will be returned on receipt of a bona fide tender. Sealed tenders, marked "Tender for Electric Lighting," must be addressed to Mr. F. H. Moger, clerk, 3, Wood-street, Bath, and delivered by the 31st inst.

Cork.—The Mayor, Aldermen, and Burgesses of the city or borough of Cork invite tenders from persons or companies willing to carry into effect the powers conferred upon the Corporation of Cork by the electric light provisional order of 1896. The Corporation of Cork have made arrangements with a tramway company, who propose installing an electric tramway system in Cork, whereby the supply of current for the tramways must be taken by the tramway company from the assignees of the electric light provisional order, and the advantages of this arrangement are specially pointed out to the intending tenderers. A copy of the conditions under which the order may be transferred, and form of tender, prepared by Messrs. Kincaid, Waller, and Manville, may be obtained from Mr. Alexander M'Carthy, town clerk, Municipal Buildings, Cork, on payment of £1. 1s., which sum will be returned on receipt of a bona fide tender. Sealed tenders, endorsed "Application for Transfer of Electric Light Provisional Order," to be sent by 12 noon on September 11 to the Town Clerk.

RESULTS OF TENDERS.

Coventry.—For installing the electric light at the Technical Institute the tender of the Coventry Gas Fittings Company, at £250, was accepted.

Coventry.—For carrying out extensions at the electric lighting works the contract of Messrs. MacCarthy and Co., Well-street, at £1,150, has been accepted.

BUSINESS NOTES.

Douglas.—The cable tramway, constructed by Dick, Kerr, and Co., was opened for public traffic on Saturday last.

South Shields.—We are informed that the Corporation electricity works will be opened on September 1, and the current will be turned on at 7.30 p.m.

Hull.—The Corporation recess has commenced, and will continue until September 24, when the Electric Lighting Committee will be the first to meet.

Dover.—The Dover Corporation have decided to light the sea-front throughout the season by festoons of 1,000 32-c.p. incandescent electric lamps, in addition to the ordinary arc lights.

Western and Brazilian Telegraph Company.—The receipts for the week ending August 21, after deducting 17 per cent., payable to the London Platino-Brazilian Telegraph Company, were £2,605.

Dewsbury.—Formal resolutions were passed at the meeting of the Guardians consenting to the expenditure already incurred of £630 for the electric light. The sum previously sanctioned amounts to £2,150.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending August 23 amounted to £1,363, as compared with £1,318 in the corresponding week of the previous year, being an increase of £45.

Institute of Chemistry of Great Britain and Ireland.—Mr. A. E. Parkes, who during the past three years has been a student at Mason College, has passed the intermediate examination of the Institute of Chemistry held in July.

Alteration of Address.—Messrs. Honeywood, Austin, and Co., makers of labour-saving tools and machinery, have taken the Grove Works, Harleyford-road, Vauxhall, which have been fitted up with an entirely new and modern plant.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ending August 21 were £2,517. 14s. 1d., compared with £2,083. 0s. 4d. for the corresponding period of last year, being an increase of £434. 13s. 9d.

Brussels.—The *Daily Chronicle* states that the concession for constructing an electric railway along the downs between Ostend and Middlekerke has just been signed between the Belgian authorities and the late Colonel North's executors.

Stockport.—An electric plant is being put down at Gaghill's Slipper Works by Messrs. Richardson, of Romiley, near Stockport. The work is being pushed on at all speed, and the coming autumn will see the large works lighted throughout with electricity.

Wrexham.—At a special meeting of the Council it was resolved that an application should be made to the Board of Trade for a provisional order to authorise the Corporation to supply electricity for public and private purposes within the borough and certain adjacent districts.

Llanelly.—The Estate Committee of the Borough Council had under consideration at their meeting a proposal of Mr. J. C. Howell for the electric lighting of the town. No definite decision was come to, the discussion being adjourned so as to enable the surveyor to make further enquiries.

City and South London Railway.—The returns for the week ended August 23 were £969, compared with £875 for the corresponding period of last year, being an increase of £94. The total receipts for the half-year 1896 were £7,498, compared with £6,883 last year, being an increase of £615.

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Bridgwater.—Alderman Peace, Councillor Waddon, and the borough surveyor have been appointed a sub-committee by the Town Council to visit other towns and make such enquiries as they might consider necessary and desirable in connection with lighting the town by means of electricity.

Folkestone.—At the meeting of the Corporation the reception and consideration of the preliminary report of Dr. Hopkinson on the provisional agreement with Mr. Hopkins, and the terms and conditions of the proposed transfer to be entered into between the Corporation and the electric lighting company was left over.

Arundel.—The electric lighting arrangements at Arundel Castle are being rearranged. It is said that the supply includes over 2,000 lamps, and the placing of them to the greatest advantage has been the subject of careful study. The plant is of a most complete character, the machinery being duplicated throughout.

Bexhill.—A long discussion took place at the meeting of the Urban District Council on the recommendation of the Highways Committee that the Council should reserve to themselves the right to purchase the proposed electric lighting undertaking by arbitration. Eventually the matter was referred back to the committee

Witton Gilbert. — Councillors Embleton, Holmes, and the chairman have been deputed by the Parish Council to see that the services of an electric lighting expert be secured, and the work inspected by him at once, the Corlett Electrical Company's account being left in abeyance until the expert's report was received.

Central London Omnibus Company, Limited.—This Company has been started, with a capital of £1,000, to carry on in the United Kingdom and elsewhere the business of electricians, electrical and mechanical engineers, manufacturers and owners of electrical vehicles and carriages, and dealers in electricity, electric machines, appliances, apparatus, motive power, traction, heat, and light.

Huddersfield.—At the meeting of the Corporation, the minutes of the Parks and Cemetery Committee showed that the question of illuminating the Greenhead bandstand by electricity—the cost of the main being estimated at £40 if laid underground and £18 if erected overhead—had been deferred *sine die*, but permission had been given to Messrs. Read Holliday to light it with acetylene, if the cost of the experiment was borne by the firm.

Nottingham.—The extensions of the buildings at the electric lighting station, Talbot-street, are now rapidly approaching completion. The size of the structure will be practically doubled, and there are to be three new boilers and two new dynamos, each of 360 h.p. The building operations have been carried out under the superintendence of the borough engineer, Mr. A. Brown, whilst the erection of the plant has been under the direction of the electrical engineer, Mr. H. Talbot.

Portsmouth.—A special committee of the Portsmouth Town Council have decided to recommend the municipal body to apply for a provisional order next session to authorise the purchase of the local tramlines owned by the Provincial Company. The estimated cost is £60,000, and the cost of taking up the lines and relaying them for electric cars would, it is believed, cost £90,000, making a total of £150,000. It is proposed to let the lines to the company at a rental which would allow of a profit.

The Great Wheel at Earl's Court.—The difficulties which have hitherto prevented the placing of an illuminated advertisement on the Great Wheel have been at last surmounted by Mr. Seymour Wade, in conjunction with Messrs. Foote and Milne, the electrical engineers, and it is announced that towards the end of this month the advertisement of a well-known London company will flash out of the darkness of the night in letters 30ft. high, 300ft. from the the ground, readable by the naked eye for 10 miles round.

City and Guilds of London Institute.—The programme of technological examinations, including regulations for the registration and inspection of classes in technology and manual training, has just been issued. The acting examiners for the year include the following: photography, Mr. Lyonel Clark and Mr. J. D. Geddes; telegraphy and telephony, Mr. J. Gavey; electric light and power distribution, Prof. W. E. Ayrton, F.R.S., and Mr Jas. Swinburne; electro-metallurgy, Prof. W. G. McMillan; and salt and alkali manufacture, Mr. A. E Fletcher.

Astley Bridge.—A special meeting of the District Council has been held to consider a resolution passed by the special committee of the Town Council on the electric traction of the tramways inviting representatives from the Astley Bridge Council to a conference of the authorities interested in the matter. In the course of the discussion it was stated by the clerk that the lease of the Astley Bridge tramways expires on September 1, 1901. The chairman of the Council (Colonel Hesketh), Captain Greg, and Mr. Orrell were deputed to attend the conference.

Electricity in Laundry Work.—The fourth annual Laundry and Sanitary Exhibition is being held at the Agricultural Hall, Islington, this week. A leading feature is the exhibit of motor-cars, for which a track 16ft. wide has been made round the galleries. A pond, 100ft. long by 6ft. wide, has also been made, on which to show electrical and other boats. The uses of electricity in laundry work are also shown, several electrical hydro-extractors being on view, as well as electrical arrangements for heating and driving ironing machinery of various descriptions.

Liverpool.—The extension of the overhead railway is being continued, and it is within the bounds of probability that cars driven by electricity may some day complete the circle around the city. The railway runs alonside of the docks from end to end, and some distance beyond. The electric power is being used just now for the purpose of painting the exterior of the structure, the paint being put on by means of a spray attached to a machine, which is worked from the electric conductor on the railway, thereby reducing the cost of skilled labour in this department from 20s. to 11s. 6d.

Clontarf. — The Dublin United Tramway Company are completing arrangements for the electrical equipment of their line to Clontarf. It is expected that the work will be commenced in time to have the electric trams running between Annesley Bridge and Dollymount by the end of the present year. Up to the present the company have no powers enabling them to employ electric traction within the city, and consequently horses must continue to draw the cars from Nelson's Pillar until they get extended powers whereby they can use electricity from start to finish of the line.

The Mumbles Railway.—Following the offer from a powerful syndicate to acquire, on terms which could not be entertained, the Mumbles Railway, and to adopt electricity as the motor power, a fresh offer (says the *South Wales Daily News*) has been received from the same syndicate which embraces terms that have led the chairman of the Mumbles Railway Company to have conferences with the syndicate. The negotiations have now reached a phase which makes business not unlikely, but owing to the absence abroad of one of the leading members of the syndicate, nothing definite can be settled till November.

An Indicating Bell Push.—Mr. J. W. Creasey, of Fife-road, Kingston-on-Thames, has forwarded to us particulars of a new indicating bell push he is putting on the market. The push button is placed out of the centre of the cover, and on the opposite side is a disc which is oscillated when a current passes. This is effected by placing a magnetic needle at the back of the indicating disc, which is over a small electromagnet. The current to the bell passes round the few turns of wire encircling the core, and hence the disc oscillates as the bell rings. Thus the operator always knows whether he has rung the bell or not.

Davies Motor Company, Limited.—This Company has been started, with a capital of £160,000 in £1 shares, to adopt and carry into effect an agreement between the Alternate-Current Ellbro Motor Syndicate, Limited, and the Company for the acquisition of certain patents and other rights belonging to the syndicate, to develop and turn to account the same, and to carry on business as manufacturers of, and dealers in, alternate-current motors, and to carry on business as electrical and general engineers, light and power contractors, electricians, electrical manufacturers, makers of dynamos, motors, apparatus, and fittings, to construct and maintain rail and tram roads, etc.

Brighouse.—The sub-committee of the Gas Committee, appointed to consider the question of purchasing the electric lighting plant from Mr. A. B. Brook, report that they have had the plant valued by Mr. Blakey, of Bradford, and they have made Mr. Brook an offer of £1 535 for the plant, which has been accepted. They recommend that the plant be purchased for this amount, Mr. Brook to work the plant at his own risk till the license to supply electricity has been obtained by the Corporation from the Board of Trade, and that afterwards the Corporation take over the plant and pay Mr. Brook £100 per annum for the use of the overhead wires till such time as the Corporation can lay them underground. The Gas Committee have recommended the report to the Council for adoption.

Hove (Brighton).—A letter was read at the meeting of the Urban District Council from the Hove Electric Lighting Company stating they were informed that the Council had acceded to a proposal made by the owners of the Stanford Estate that this company be permitted to extend their electric lighting mains from the top of Wilbury-road across from the Hove boundary to the corner of the Stanford Estate in Upper Shoreham-road on condition that they entered into an agreement with the Council to remove the mains if and when called upon to do so. They, therefore, enclosed a draft agreement, adding that if it was approved they would send a copy executed by the company, and ask the Council to execute a duplicate on their part. The agreement was approved, subject to a few minor alterations.

Fort William.—The streets in Fort William have just been lighted by electricity, supplied by the Fort William Electric Lighting Company, Limited. So far only two arc-light pillars of 1,000 c.p. each have been erected, but it is expected that the other four for the main street will be in position in little more than a week. Two of these latter pillars will contain drinking fountains of an ornamental description, and are to be placed in Gordon-square and Fraser-square respectively. In addition to the arc lights there are to be over 60 16-c.p. incandescent electric lamps, all of which will be in working order in about a fortnight. The light given by the arc pillars already erected was of the most satisfactory description. Experiments in cooking and heating by electricity were also made on Saturday night, and the results obtained gave entire satisfaction. The electric lighting company are also to give an exhibition of electricity as a motive power applied to farm implements at the Lochaber Agricultural Show on the 15th prox. Besides a number of private houses and hotels in Fort William, the Episcopalian and Catholic Churches have already been lighted by electricity.

Appointment Vacant. — The Hammersmith Vestry invite applications for the appointment of resident engineer, to supervise, under the consulting engineer, the erection of the electric lighting plant and other works in connection therewith, and afterwards to undertake the management and control of the electric light department. The person appointed will be required to reside in

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the parish, and must give the whole of his time to the duties of his appointment. Applicants must have a thorough mechanical training, and be well versed in the erection and running of boilers, engines, and electrical machinery. Salary £200 per annum during the erection of the works, etc., to be increased to £250 when the installation is completed and in working order. Forms, upon which applicants must send in their applications, may be had from Mr. W. P. Cockburn, vestry clerk, Temporary Offices, 57, Fulham Palace-road, Hammersmith, and any further information may be obtained upon application to Mr. A. H Preece, consulting engineer, 39, Victoria-street, Westminster. Applications, marked on the outside "Resident Engineer," must reach the vestry clerk by 4 p.m. on September 2. Canvassing both personal or otherwise will disqualify candidates. Applicants will not be required to attend, and no travelling or other expenses will be allowed.

Manchester.—The suburban authorities in the vicinity of Manchester, particularly those having jurisdiction on the south and south-western sides, are just now considering proposals for the establishment of the electric light within their several areas. The Corporation are desirous, it is understood, to extend their electric light system into the suburbs, and with this object in view the Gas and Electric Lighting Committee propose that a conference of the local authorities of Moss Side, Withington, Stretford, and Levenshulme should be held. We understand that a company has been formed, under the title of the South Manchester Electric Supply Company, Limited, and has offered to supply the Moss Side district with the electric current for lighting purposes. A powerful syndicate of capitalists have also undertaken not only to give the electric light to residents in the Manchester suburbs, but to provide an extensive system of electric tramways. This syndicate, acting in conjunction with Messrs. Andrews and Butterworth, architects and surveyors, of this city, and Mr. Joseph Sampson, of Albert-square, solicitor, have already approached some of the local authorities and intend in the course of the next few days to have interviews with others, with the object of arranging terms for installing the electric light and providing electric haulage for tramways.

Southport.—The demand for the electric light not having been taken up to the extent anticipated, the Electricity Committee arranged an exhibition of alternating-current arc lamps, motors, etc., which is being held this week. The exhibition included two lamps of 15 amperes, or 1,200 c p., by the German Electrical Company; two Helios lamps of the same power running parallel off a transformer; two Lewis 12-ampere lamps by Messrs. Fowler, of Leeds, running on the reacting system; two more of the German Electrical Company's lamps, of 900 c.p., running in series, and shown by Messrs. Calvert and Co., of Manchester; also two of Crompton's, and two from the Brush Company, all of 1,200 c.p., running in series. These arc lamps differ from those at present in the streets, which are supplied with a rectified current, whereas those on view were supplied direct from the mains. In addition to the arc lamps there were a number of small motors in use, two of them driving sewing-machines, while a third, of ½ h.p., ran unharnessed. A couple of fans for ventilating purposes, a number of heaters, an electrically-heated kettle, and a working diagram of a Raworth-Brush steam-engine were also included in the exhibition. The arrangements were in the hands of the borough electrical engineer, Mr. Charles D. Taite. Current is now being supplied by the Corporation for motors and heating apparatus at 4d. per unit.

Llandudno.—At the meeting of the Urban District Council the surveyor submitted three tracings showing suggested alternative sites for the erection of electric light station and destructor works, also showing in conjunction therewith the proposed siding to the gasworks and temporary road, and the enclosing of an additional three acres of land. The committee adopted scheme No. 2, which shows the electric light station and destructor at the rear of the gasworks. The committee were of opinion that it would be advisable to procure a quantity of land, in addition to the land above mentioned on the north-east side of the gasworks, amounting to three acres or thereabouts, and they requested the surveyor to prepare an amended plan and forward a copy thereof to the Mostyn Estate and ask for terms for the purchase or lease of the land in question. On the suggestion of the engineer, it was decided to ask Mr. A. H. Preece and Mr. Deas to meet the chairman of this committee and the engineer to the Council to discuss and settle various questions connected with the combined scheme. The engineer reported that he had considered the question of destructor chimney, and estimated the approximate cost at £1,100 to £1,200. He had also estimated that the cost of carrying a shaft up the Bryniau Hill as suggested would amount to about £3,000. The committee considered that the latter course was out of the question.

Brighton.—The Lighting Committee reported at the Town Council meeting that at a meeting of the Lighting Committee on August 10 the surveyor stated that the lamps in Sussex square were of an old pattern and not suitable for electric lighting purposes. He was instructed to replace the lamp pillars with others which he had in stock. The town clerk submitted a letter he had received from Callender's Bitumen Telegraph and Waterproof Company, Limited, stating that their business had been transferred to Callender's Cable and Construction Company, Limited. The committee recommended the Council to consent to the transfer of the contract, dated July 23 last, for the supply of armoured cable during the 12 months ending May 1, 1897, subject to the sureties named in the bond for the performance of the contract entering into a fresh bond to secure the performance of the contract by Callender's Cable and Construction Company, Limited. The manager was granted one month's leave of absence. The town clerk reported that Messrs. Reed and Son had applied for an extension of time for the delivery of the electric light bracket posts under their contract. An extension of time to August 15 for the delivery of the first 20 bracket posts, the remainder to be delivered at the rate of five per week, was recommended. The manager reported, suggesting that tenders be invited for the purchase of old scrap iron and scrap cable ends at the electricity works, and the suggestion was approved of and ordered to be acted upon. These proceedings were confirmed.

White Lead Admixtures.—We have received the following circular letter from Mr. Kenric B. Murray, secretary of the London Chamber of Commerce: "I am directed to inform you that the leading white lead corroders have resolved to support the action taken by this Chamber in this matter as far as lies in their power, and to induce their friends to adopt the same course. With this view they have decided (1) to discontinue the use of the term 'best' as a trade description for admixtures of white lead, believing it to be a false and misleading description within the meaning of the Merchandise Marks Acts, 1887 and 1891; (2) to brand or stencil all packages, wooden or iron, containing white lead admixtures with the word 'reduced'; and (3) to invoice all white lead admixtures as 'reduced white lead.' These measures are proposed in the interests of the reputation of English trade, and will, I feel sure, meet with universal support. The responsibility for the illegal and dishonest practice of selling reduced white lead as 'genuine' (which might be unjustly fastened upon the manufacturer, in the event of his having supplied reduced white lead without brand or mark, and the packages being subsequently branded or marked by a second party 'genuine') will, it is hoped, by the means proposed, be brought home to any who are guilty of the dishonest practice. These resolutions will come into force and take effect on and after October 1 next, so that sufficient time is thus afforded to all parties to make any necessary arrangements as to alterations in trade lists, brands, marks, etc., consequent upon the decision intimated in this letter."

Canterbury.—A special meeting of the Corporation has been held for the purpose of considering the minutes of the Whole House Committee meeting on the question of the inclusion of the proposed dust destructor with the scheme of the electric lighting works. The town clerk read the minute of the committee meeting as follows: "The committee recommended that the question of the site for the electric light works and dust destructor, on the advice of the town clerk, that the Millers' Field is not available for the purpose, be reconsidered by the committee and that they report." Councillor Harris moved that the words "and dust destructor" be omitted from the minute. This was seconded by Alderman Wells. Councillor Lukey was very sorry that they had submitted that amendment. It had been understood throughout by the members, or a majority of them, that the dust destructor should run in double harness with the electric light. The amendment now proposed would narrow the matter down to the smallest degree, and was one that he for one did not approve of. The dust destructor was advocated with a view to saving in producing the electric light. He felt that was not the proper time to have the amendment so ably put by Councillor Harris before them. He trusted that that Court would let their original idea stand, and decide to let the electric light and dust destructor, as arranged in the meeting, go together. Councillor Horsley agreed with Councillor Harris that the site that suited one purpose might not suit the other. Could they not alter the wording of the minute so that the committee, while reconsidering the matter of a site for the electric light, might also be on the look out for one for the dust destructor at the same time? The chairman, after some further discussion had taken place, put the amendment, which was lost by eleven votes to seven. The original minute was then put and carried with only two dissentients.

Edinburgh.—The revenue of the electric lighting undertaking for the year to May 31 was £25,862, and the expenditure £11,590, to which is added depreciation written off capital £6,329, the balance carried to profit and loss account being £7,943. The committee had to meet the following requirements: interest on loans, £4 246; sinking fund, £1,316; leaving a surplus on the year's operations of £2,381, which is transferred to the credit of the gas account. In view of the favourable balance, the committee have approved of the recommendation by the special sub-committee that a reduction in the price of current, on a scale which necessitates a new method of charging, should take effect as from and after June 1 last. This new method, the committee anticipate, will increase the popularity and use of the electric light. Indicators will be placed in consumers' premises to ascertain the greatest quantity of electricity taken at any one time during the year, which quantity is called the "maximum demand." To customers who use in the year the maximum demand for 365 hours only, being an average of one hour per day, or any lesser quantity, the price charged will be at same rate as at present—viz., 6d. per Board of Trade unit; but for all electric energy used over this quantity that the charge will be at the rate of 4d. per Board of Trade unit. The committee have also approved of the recommendation made by the Special Sub-Committee that the charge for meter hire be discontinued from and after September 1, and that so soon as the current for the supply of street lamps is taken from Waterloo street station, instead of John-street station, the price charged for each lamp should be reduced from £26 to £20 per annum. The number of consumers at May 31 last was 855, being an increase of 269 over the number at same date last year. The quantity of electricity sold during the past year to private consumers, irrespective of public lighting, was 866,606 Board of Trade units, being an increase of 24·11 per cent.

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Great Horton.—An enthusiastic public meeting was held a few days ago to consider the desirability of a tramway being laid to the town, and a resolution was passed urging the Bradford Town Council to take immediate steps to bring this about. Mr. W. C Dixon, chairman of the Gas and Electricity Supply Committee of the Bradford Corporation, said that they had at their electricity works a great amount of electric power standing idle during the daytime, which would bring all the people to Great Horton who wanted to come, and without any cost to the Corporation. People were now getting their eyes opened to what electricity could do, and orders were being received for motors for all kinds of driving power. The committee were putting down a gigantic station, which would be one of the finest in England. Bradford had been the first municipal borough to take up electric lighting, but they had let other places outstrip them. Alluding to the tramcars of America, which were both run and lighted by electricity, he said that the electric cars in Boston carried more passengers than all the locomotives in the State of Massachusetts put together. All over the world the electric cars were beating all the other kinds of cars, and he took it as a settled thing that if they were to have trams run to Great Horton they would be run by electricity. He believed the Labour members of the Council were afraid that if a tramway were run to Great Horton and it didn't pay this would jeopardise the municipalisation of the tramways six years hence. He did not agree with that, but considered that they ought to try an experimental line before taking in hand a large scheme. At a subsequent meeting of the Bradford Corporation it was decided to apply for parliamentary powers to construct lines along Bolton-road and also to Great Horton. With regard to the Great Horton scheme representatives of the British Wire Company demonstrated to the committee the utility of their system of laying underground electric wires for the running of trams. and Mr. Cox, the borough engineer, was instructed to prepare plans showing the length of cable that would be required.

Mitchelstown.—Now the area of taxation for the electric light scheme comes to be defined the Guardians are meeting with some objections. The valuation of the town is £2,900, but by taking in some extra lands, as the Board wished to do, the valuation would be increased to £3,500. The following letters were read at the last meeting: "Flemingstown, August 20, 1896. Sir,—I hereby give you notice, as clerk of Mitchelstown Union, that I will not consent to have my agricultural holding at Brigoun included in the area of taxation for the Mitchelstown electric lighting, but will oppose any further increase of rates on my lands to the utmost of my power. I consider it enough to have to pay the increased rate for electric lighting on my house property in town. My cattle can graze without electric light, as they have always done. When I wanted to obtain what would be of use to my cattle—viz., water—I could not get it, though I offered to pay the Guardians as much as any other person for it.—Yours, etc., ELLEN COUGHLAN." "The Square, Mitchelstown, August 9, 1896. Sir,—I have been informed that at last meeting of the Board of Guardians here the area of taxation for electric lighting the town was under consideration, and, I understand, was adopted by them. Now I am told that the original area was altered unknown to many of the Lighting Committee immediately before the Board meeting, and without consulting the ratepayers, and that a piece of land, the valuation of which is £14, which I hold outside the town, at Ballinvullen was smuggled into the area at the last moment. There is no residence on the land. In case this scheme for the lighting of the town becomes law I shall have to pay in the town alone taxes on a valuation of £63. 10s., but if this land is added on unknown to me, I must protest against such an unjust proceeding. Owing to the manner in which the committee was formed, too much confidence should not be placed in it as the members were elected by two factions and large ratepayers excluded. It is my opinion that no sanction should be given to their recommendations until an experienced engineer examines and approves of the number of lamps proposed to be erected as well as the available water supply.—I am, Sir, yours, etc., EDWARD WALSH." After some discussion it was decided that the consideration of the area of taxation should be referred to a committee.

Cardiff.—At a meeting of the Chamber of Commerce it was reported that Mr. Gaine, general manager of the National Telephone Company, had recently had an interview with Messrs. John Gunn, H. J. Simpson, J. Andrews, and G. N. Kestell on the subject of amalgamation of the telephonic systems. Those representing the Chamber urged that the systems should be acquired by the Government, and that in the meantime the subscribers to the two systems in this district should be allowed to communicate with each other the same as was done in certain areas. Mr. Gaine had told them that the Government had acted rather unfairly towards the National Company. In Cardiff and Newcastle the Government had encroached upon their preserves, and must be looked upon as competitors, and the question of the Government acquiring the National Telephone Company's system was one with which he could not deal. As to the using of both systems, he pointed out that the National Company had 800 subscribers in the Cardiff district, while the Government had only 150, and such an arrangement would certainly not be equitable or fair to the former. The Chairman said it was a fact, as stated by Mr. Gaine, that it was only at Cardiff and Newcastle that the Government competed with the National Company, and explained that the latter had a capital of about two millions sterling at stake. The directors were, therefore, bound to study the interests of the shareholders. Mr. Gaine had, however, promised to do all in his power to remove grievances complained of by subscribers, and had expressed himself in favour of Barry being included in the Cardiff area, although his directors were not agreed as to that. If Barry were included, subscribers doing business there would save a considerable amount of money annually. Mr Coward and others complained that since the Government had got possession of the trunk lines communication had been worse than before, Mr. Coward stating that the delay in getting through and the cutting off of the connection too soon was so great that he decided to give it up at the end of the year. On the motion of Mr. W. Lester Jones, seconded by Mr. J. Andrews, the following resolution was unanimously agreed to: "That in the opinion of this Chamber, Barry should be declared within the Cardiff area of the National Telephone Company, inasmuch as Barry is in the Customs port of Cardiff, and the business there is almost wholly conducted from Cardiff."

Hastings.—A Local Government Board enquiry has been held by Mr. Rienzi Walton into the application of the Town Council to borrow £7,560 for purposes of electric lighting. The Town Clerk stated that about the year 1890 they obtained a provisional order for public lighting purposes, and it was not thought desirable to get a public lighting order. They had not availed themselves of the order up to the present time, it having been done by contract with the local electric lighting company—this contract would expire in less than a year, in July, 1897—the company lighting the front line and also the various public buildings, such as the Town Hall and Brassey Institute. They paid £27 for 52 lamps along the front, and the other was paid by meter. The Corporation had been in negotiation with the company, as the end of the contract was approaching, as to what the company would be prepared to do, and they had received an intimation that the present system did not answer the purposes of the company, and if it were continued, the price would be considerably enhanced. A sub-committee had gone very carefully into the matter, and had come to the conclusion that it would be much better if they (the Council) had an electric lighting system of their own, and by so doing there would be a considerable saving to the ratepayers. The Council now asked the Local Government Board's sanction to borrow this sum to make alterations to buildings and for plant, and for the cost of various appliances which they would have to take over from the company under the existing contract. A special plant had to be provided for public lighting purposes. They had been in communication with the Board of Trade, but had not received any intimation that they approved of the system of supply. In reply to the inspector, Mr. P. H. Palmer (the surveyor) said at present the Council only intended to light the 52 lamps along the front line from the end of Marina to the fish market, a distance of about 2½ miles. The public station they acquired some 40 years ago, and the premises covered an area of about 1,070 square yards. Mr. Palmer explained the alterations that would take place, and said there would be two boilers of 154 h.p., three steam dynamos, and the necessary instruments. The arc lamps were supposed to be of 2,000 c.p. each, and each dynamo was capable of supplying 35 lamps. The steam-pipes, etc., were provided for in the estimate. They did not intend to do any private lighting, though they would supply the public buildings. The estimates provided for the extension of street-lighting. There was no opposition to the loan.

Lambeth.—The Vestry having decided, with the consent of the Board of Trade, to transfer their provisional order to Mr. C. W. Sax, have given public notice of their intention. The transfer contains the following provisions: (*a*) That the said transfer will comprise the whole of the area in respect of which the said order was made, such area being the whole of the parish of Lambeth, with the exceptions set out in the first schedule to the said order. (*b*) That the said transfer will be for the whole period covered by the said order, with an option to the Vestry to repurchase the whole undertaking on giving 12 months' notice at the following periods—viz. (1) at the end of 21 years on payment to the transferee of 25 per cent. over the price that would be fixed under the statutory compulsory power of purchase, provided for by the Electric Lighting Act, 1888; (2) at the end of 31 years on payment of the statutory compulsory terms without any addition thereto. (*c*) That the pecuniary consideration for the intended transfer is to be the payment of £1,000 to cover the expenses actually incurred by the Vestry in obtaining the order, and the expenses incurred thereunder, and in connection with the transfer of the order. (*d*) That the price to be charged by the transferee for a supply of energy shall be 6d. per Board of Trade unit, such price to be reduced by not less than ¼d. per unit for each 1 per cent. of dividend declared over 6 per cent. on the whole ordinary stock or share capital of the undertaking, such 6 per cent. to be on an average of years. (*c*) That the transferee shall deposit with the Vestry the sum of £100 to cover the cost of works, under Clause 14 of the order, and pay expenses of work from time to time. (*f*) That the transferee will supply energy for lighting the public lamps on the Vestry undertaking to take the energy for three years, the price to be settled by agreement. and in case of difference by arbitration. (*g*) That the transferee shall not consent to the revocation of the order without the approval of the Vestry, but may transfer the undertaking upon terms to be approved by the Vestry, but no part of any premium to be claimed by the Vestry. (*h*) That the transferee shall deposit £5,000 with the Vestry as a guarantee for the completion of the compulsory electric work within two years from the date of the transfer, the Vestry to pay to the transferee 2 per cent. interest, but the deposit to be forfeited to the Vestry if the works are not completed within three years. (*j*) That the transferee shall supply the electric current free of charge for 25 public arc lamps to be erected by the Vestry. (*k*) That the transferee shall erect and maintain a refuse

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destructor, and cremate thereby the whole of the dustbin refuse to be supplied by the Vestry, the Vestry undertaking to deliver the dustbin refuse of at least one-half of the area of the parish, and to pay to the transferee 11½d. per ton for the refuse delivered, the destructor to be considered as part of the undertaking if the option to purchase is exercised by the Vestry. (*l*) That Sections 9, 31, 55, 56, 57, and 72 of the order shall not apply to the transferee.

Leeds.—In connection with the new electric tramways, which the Corporation propose to work between Roundhay Park and Kirkstall, a commencement has been made with the relaying of the lines on the Kirkstall section. A large staff of men are engaged in taking up one track, the traffic in the meantime being conducted on the other line, which, with the view of meeting the public convenience, has been left undisturbed. At the other end of the electric section considerable progress has been made with the construction of the tramlines from the new entrance to Roundhay Park to the Canal Gardens, and should no unforeseen circumstances arise there is every reason to hope that in the course of a few weeks the road will be finished, and pending the completion of the electric equipment steam cars will probably be run to the Canal Gardens. The Tramways Sub-Committee of the Highways Committee at their last meeting had before them the applications for the position of clerk of works for the electrical equipment of the tramway. The applicants numbered 35, and the committee selected the following five to appear before them at a meeting to be held next week: Mr. H. G. Sprague, Dublin; Mr. Frank B Lea, London; Mr. John Burbridge, Leeds (late manager for the Thomson-Houston Company on the Roundhay section); Mr. Ernest K. Scott, Wolverhampton; and Mr. C. F. F. Smith, Blackpool. The salary will be fixed when the appointment is made. The application from the tramway servants for an increase in their wages was also brought before the committee, and it was decided to hold a special meeting to consider the matter. At the meeting of the Highways Committee of the Corporation the members spent several hours in visiting various parts of the city where it has been suggested that tramways should be laid. It was ultimately decided to place several routes before the City Council, and recommend that application be made for the necessary powers of construction The new lines which it was decided to recommend are as follows: from Tong-road, near the Crown Inn, along Oldfield-lane and Upper Wortley-road to the Star, where the present Wortley system terminates; from Wellington-street, down Aire-street to the Cattle Market, by way of Whitehall-road and Gelderd-road; from the junction of Dewsbury road and Meadow-road, along Meadow-road, Beeston-road, and Beeston-hill, to near the school at the end of Town street, Beeston; from the junction of Beeston-road and Elland road for some distance up Elland-road; from Dewsbury-road along a new road which it is intended to form; from Dewsbury-road to Moor-road, Hunslet, along Moor-road to Hunslet Carr, Balm-road, and Church-street, to join the Hunslet tramway in Hunslet Low-road, from New Market-street along Vicar-lane to North street, when the contemplated widening has been carried out; along Infirmary-street, East-parade, Calverley-street, Great George-street, Clarendon-road, Moorland-road, Hyde Park-road, to Hyde Park-corner; along Park-lane from East-parade to Burley-street, Burley road, Cardigan-road, St. Michael's-road, joining the Headingley tramway at the Oak; from the bottom of Victoria-road, Headingley, down Woodhouse-street and Cambridge-road, joining the Meanwood tramway. It was also decided to recommend the City Council to apply for power to extend the tramway, which has been authorised to be carried to near the New Inn, Tong-road, to extend it to some little distance above that point; also to continue the authorised tramway terminating at the New Inn, Dewsbury-road, to the entrance to Cross Flatts Park. It was reported to the committee that under the Act which received Royal assent in July last, the Corporation obtained powers to construct the following tramways: Prince's avenue to Roundhay Park; bottom of York-road to Victoria avenue; Meanwood-road, from Buslingthorpe-lane to Monkbridge-road; Tong-road, from the present termination to near the New Inn; Whingate, from Tong-road to Town street, Armley; Armley-road, from Wellington-road to near the bottom of Branch-road, Armley; Abbey-road, Kirkstall, from present termination to Kirkstall Abbey; Meadow-lane and Dewsbury-road, from Bridge End to near the New Inn. Revived powers under the Act of 1888 had been obtained for the construction of a tramway along Beckett-street, Burmantofts-street, and York street to its junction with Kirkgate.

Glasgow.—With a view to the ultimate adoption of a system of lighting their trains by electricity, the Caledonian Railway Company have had an experimental train fitted up in their works at St. Rollox, and a trial has been made on the new Underground Central Railway. The train consists of seven six-wheeled carriages—two first-class, three third, and two third brakes. The system now being experimented with is that of Messrs. J. Stone and Co., which has been previously described in these columns. Each vehicle carries its own generating plant, the motion of the carriage producing the electricity, and storing it in an accumulator, which automatically comes into action when the train slackens speed or stops at stations. The dynamo, which is driven by means of a light strap or belt direct from a pulley on the axle, is suspended from the underframe of the carriage in such a manner that absolutely none of the vibration of the axle is transmitted to it. However the speed of the axle may vary, the dynamo always runs at a uniform rate, and always produces the same amount of electricity. A mechanical governor automatically connects the dynamo to a small accumulator when the train is in motion, and the lamps then take their current direct from the accumulator. On the train stopping the supply is maintained to the lamps from the accumulator, which has a storage of fully seven hours. Each carriage is provided with a switch, so arranged that the light can be fully or partially on or altogether cut off. There are two lamps in each compartment. Before the system is further extended it will be given a thorough practical trial on the Central Railway between Rutherglen and Maryhill. At the meeting of the Corporation Mr. R M. Mitchell moved the approval of the minutes of the Gas and Electric Lighting Committee. The minutes contained a recommendation, already published, to the effect that a new method of charging for electric light should be adopted—viz., to customers who use in the year the maximum demand for 365 hours only, being an average of one hour per day, or any lesser quantity, the price charged will be the same as at present—viz., 6d. per Board of Trade unit; but for all electric energy used over this quantity the charge will be at the rate of 4d. per Board of Trade unit. Mr. Ferguson wished to know the relative cost of gas and electric light. Mr. Mitchell said he understood that the electric light cost about 2½ times more than gas. The Chairman said his experience was that the cost was a little more. Mr. Ferguson asked whether a current of 500 volts was dangerous. Mr. Mitchell said he understood there was no danger with such a current. Mr. Primrose congratulated the committee on the financial statement submitted. It showed gratifying progress in the development of the new light. He noted with special gratification the recommendation of the committee to adopt the new system of charging. No one who had witnessed the operation of the system in such a town as Brighton but must be satisfied that it would be an advantage to the consumers. Mr. Fife, in moving the adoption of the report of the committee, said that it must be a source of gratification to all concerned that the year's work had resulted in favourable financial balances. In the electric lighting department the committee felt satisfied that they were working on good sound financial lines, and these had now been verified by the results of the last year's work, turning a deficiency of last year, £1,527, into a surplus this year of £2,580, and this after providing amply and fairly for depreciation and sinking fund. The committee believed they had in the Waterloo-street works one of the best electric lighting stations for its size in the country. In order to develop its utmost producing powers the committee, after very careful investigation by a sub-committee, under the convenership of Bailie Burt, recommended a change in the mode of charges—first, to abolish the charge for meter rents, a saving of some £300 per annum to the consumers; second, that the price be 6d. per unit for the first hour of each day and 4d. per unit for every hour thereafter, thus meeting the case of those who could use the current for a longer time, and which would enable the plant to be worked with more regularity and economy. They asked that this, the Brighton system, should have a fair trial, as, so far as could be judged, it might lead to further reductions in the future. The Watching and Lighting Committee must also be gratified with the recommendation of the committee to reduce the price per lamp from £26 to £20, the lowest in the kingdom for a continuous light of the power now furnished. Bailie Burt said they ought to encourage the use of electric motors during the day; and as they understood they were in use from eight to ten hours per day, the man who kept a motor going that time would get the benefit of the reduction. With reference to additional generating stations and mains, so as to supply the whole city, the committee did not feel ready to bring up a report on such an important subject. He felt that they had been set back a little by the delay in settling the question of electric tram way traction. The committee felt that should the city adopt some mode of electric traction they would present a solution of this electric lighting question that could not be found under existing circumstances. He had not the slightest fear of gas and electric light coming into rivalry. If they supplied gas at a cheap rate, they might have the majority of the citizens using it instead of coal for heating and lighting purposes. He was glad that the Council had adopted the report without any very serious objection because he felt it was some compensation to the committee for the time and labour they had expended upon it. He was satisfied that they were really in the front so far as their system of electric lighting was concerned, more especially as the Board of Trade had raised the pressure to 500 volts, Mr. Ferguson had asked if 500 volts was dangerous, but the Board of Trade did not consider it dangerous, or they would not have allowed the pressure to be raised without the wires being specially insulated. If the electric lighting was to be developed, he felt that the Council would have to face a very large extension of the generating station. The question for the committee next year would be whether they should acquire more ground and extend the station in Waterloo street, or institute small stations throughout the city. The settlement of the tramway traction question would to a very large extent influence the committee in their decision. Mr. Ferguson suggested that, instead of borrowing on interest, notes on the security of the rates should be issued. He observed that the sum carried forward from the electric lighting account had been transferred to the gas account. He did not think this was right financing. The balance should have gone to the development of the electric light. Mr. Fife said it certainly did seem anomalous. But the accounts must be kept in accordance with the provisional order. The gas department during the three previous years bore the deficiency on the electric lighting account. The first year that deficiency amounted to £1,773, the second to £607. 3s., and the third to £1,527, and this was the first sum that had been paid towards that deficit. When they had squared the account they might rest assured that the consumers of electric light would receive the full benefit.

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PROVISIONAL PATENTS, 1896.

August 17.

18191. Improvements in galvanic batteries. Julius Brandt, 6, Lord-street, Liverpool.

18196. Improvements in the construction of tubes and tubular electric conductors. Joseph Devonport Finney Andrews, 45, Fulham Park-gardens, London.

18205. Improvements in electrically-operated carillons. Edgar Herman Carqueville, 45, Southampton buildings, Chancery-lane, London.

18220. An improved meter or apparatus for registering the consumption of alternating electric current. James Yate Johnson, 47, Lincoln's-inn-fields, London. (Messrs Hartmann and Braun, Germany.) (Complete specification.)

August 18.

18249. An improvement in the preparation of filaments for glow lamps. William Samuel Tothill Martin and Henri Weymersch, "Lyncote," Green-lane, East Dulwich, London.

18273. Improvements in dynamo-electric machines. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Robert Lundell and Edward Hibberd Johnson, United States.) (Complete specification.)

18312. Improvements in induction telegraphy. Sydney Evershed, 1, Queen Victoria-street, London.

18317. A new or improved device for use in connection with electric railways. Frederick Carleton Esmond, Norfolk House, Norfolk-street, London.

August 19

18319. A new or improved electric hand lamp for general or special purposes. Arthur John Westmancott, 22, Alfred-street, Islington, London.

18326. Improved preparations for accumulator plates. Henri Weymersch, 58 Oakhurst grove, East Dulwich, London.

18364. An improved electric motor or dynamo-electric machine. John Thomas Knowles, of the firm of D. Young and Co., 11, Southampton-buildings, Chancery-lane, London. (James Harold de Thierry, Italy.)

18408. Improvements in the production of electric light. Joseph Dobson, 37, Chancery-lane, London.

August 20.

18420. The practical application of the electric light to bicycles, tricycles, carriages, and all motorcars. Frederick Ritchie, 113, Burdett road, Bow, London.

18454. Improvements in incandescent electric lamps. Jan Meines Huisman and Henry Charles Gover, 62, St. Vincent street, Glasgow.

18464. Improvement in electric gas-lighters. Erik Orling, 163, Queen Victoria-street, London. (Date applied for under Patents, etc., Act, 1883 Sec 103, 23rd April, 1896, being date of application in Sweden.)

18469. Improved method of and means for attaching telegraph and other wires to insulators. George Middleton, 55, Chancery-lane, London

18479. Improvements in the manufacture of electric cables. Mervyn Joseph Pius O Gorman, 24, Southampton-buildings, Chancery-lane, London.

18485. Improvements in acid-proof electrical non-conducting articles and composition therefor William Morison, 119, West Forty-second street, New York.

18497. Improvements in electrical measuring and signalling instruments. Herbert Watson Sullivan, 40, Chancery-lane, London.

August 21

18508. Improvements in arc lamps. Joseph Edmondson, Penny Bank-chambers, Halifax.

18522. Improvements in automatic signals William Edward Langdon and William Llewellyn Preece, Midland Railway, Derby.

18537. Apparatus intended to determine the quantity of metal which a galvanoplastic bath should deposit on the object treated. Joseph Ducot, 8, Rue des Princes, Brussels

18549. Improvements in or relating to electrical primary batteries. Joseph Bruce Whittemore, 36 Chancery lane, London. (Complete specification.)

18570. Improvements in electric batteries. Fritz Dannert, 40 Chancery-lane, London. (Complete specification.)

August 22.

18580. Improvements in and relating to electrical ceiling roses, switches, and the like. William McGeoch, 96, Buchanan-street, Glasgow.

18593. An improvement in electrical apparatus. John Forrest Kelly, 11, Southampton-buildings, Chancery-lane, London. (Complete specification.)

18628. Incandescence body for electrical glow lamps and process of manufacture of the said body. Josef Franz Bachmann, Adolf Vogt, Carl Camillo Wiener, Josef Kirchner, and Albert König, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

18627. A depolarised galvanic element. Albrecht Heil, 28, Southampton-buildings, Chancery-lane, London.

18632. Improvements in holders for incandescence electric lamps, also applicable to the holding of the shades or reflectors thereof. Hugo Hirst and George Edwin Fletcher, 73, St. Stephen's-road, Upton Park, London.

18648. Improvements in electrical storage or secondary batteries. Rankin Kennedy, 33, Gladstone-street, Bradford.

18649. A new or improved recording electricity meter. Rankin Kennedy, 33, Gladstone-street, Bradford.

18651. Improvements in commutator brushes for dynamo-electric machines or electric motors. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London (Robert Lundell, United States.) (Complete specification.)

18652. Improvements relating to electric railways. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Robert Lundell) United States.) (Complete specification.)

SPECIFICATIONS PUBLISHED.

1895.

14493. Electromotors and dynamos. Hollick and Hollick.

15868 Arc lamps Andrews.

16019 Incandescent electric lamps and their holders and fittings. Johnson. (Swan.)

17505 Electrodes Hoepfner.

17741. Device for indicating the duration of telephonic conversations Van Kerckhove.

17871. Compositions for protecting ships' bottoms against fouling, preserving wood, and shielding submarine electric cables from penetration by toredo worms. Gunn.

18369. Elect ic locomotives. Amen.

1896.

11441. Electric arc lamps. Adams.

14005. Apparatus for automatically closing and opening by electrical agency the barriers of railway level crossings. Van der Valk.

14187. Portable electric drill. Holmes and Siemens Bros. and Co., Limited.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5¼-5¾
Brush Company, Ordinary	3	1¼-1½
—— Non. Cum., 6 per cent. Pref.	2	1⅜-1⅝
—— 4½ per cent. Debenture Stock	100	112-115
Central London Railway, Ordinary	10	10½-11
——	2	2¼-2½
Charing Cross and Strand	5	9¼-9¾
Chelsea Electricity Company	5	7¾-8¼
—— 4½ per cent. Debentures	100	114-117
City of London, Ordinary	10	16-17
—— 6 per cent. Cumulative Pref.	10	17½-18½
—— 5 per cent. Debenture Stock	100	112-116
City and South London Railway, Consolidated Ordinary	100	50-52
—— 4 per cent. Debenture Stock	100	136-128
—— 5 per cent. Pref. Shares	10	14½-15
County of London and Brush Provincial Co., Ordinary	10	8-9
—— 6 per cent. Cum. Pref.	10	13½-14
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2¼
Edison and Swan United Ordinary	3	1¾-2¼
—— 4½ per cent. Debentures	100	103-106
Electric Construction, Limited	2	1⅛-1⅜
—— 7 per cent. Cumulative Pref.	2	2¾-3¼
Elmore's Copper Depositing	2	¾-1
Elmore's Wire Company	2	⅜-⅝
W. T. Henley's Telegraph Works, Ordinary	10	18-19
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	112-117
House-to-House Company, Ordinary	5	4-4½
—— 7 per cent. Preference	5	8¾-9¼
India Rubber and Gutta Percha Works	10	22-23
—— 4½ per cent. Debentures	100	107-110
Kensington and Knightsbridge Ordinary	5	9½-10
—— 6 per cent. Pref.	5	7¾-8¼
Liverpool Electric Supply, Ordinary	5	8-8½
Liverpool Overhead Railway	10	13¼-13¾
—— 5 per cent. Pref.	10	17⅛-17⅝
—— 4 per cent. Mortgage Debentures of £100	100	112½-114½
London Electric Supply	5	⅞-1⅛
Metropolitan Electric Supply	10	13¼-13¾
—— 4½ per cent. First Mortgage Debenture Stock	100	120-123
National Telephone, Ordinary	5	7¼-7¾
—— 6 per cent. Cum. First Pref.	10	17-19
—— 6 per cent. Cum. Second Pref.	10	17-18
—— 5 per cent. Non. Cum. Third Pref.	5	6¾-7
—— 3½ per cent. Deb. Stock	100	107-110
Notting Hill Company	10	11-12½
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8¼-8¾
—— £4½ shares	4½	7¼-7¾
Oriental Telephone and Electric Company	1	¾-⅞
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	102-107
Southampton Electric Company	5	4¾-5¼
St. James's and Pall Mall, Ordinary	5	12-13
—— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	39-42
—— 5 per cent. Bonds	100	103-106
Waterloo and City Railway, Ordinary		8-8½
Westminster Electric Supply, Ordinary	5	11-12
Yorkshire House-to-House	5	7½-8

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NOTES.

American Institute of Electrical Engineers.—We have to acknowledge the receipt of No. 4 of vol. xiii. of the *Transactions* of this society.

Fire.—Mr. A. Vaughan Stevens's house at Harpenden has been burnt down. The cause of the fire has been ascribed to the heating and fusing of the wires used for the electric lighting of the building, but on what grounds we do not know. The family were away, and there was no one in the house at the time except the housekeeper.

The Midland Engineers.—The annual meeting of the Chesterfield and Midland Counties Institution of Engineers was held last week at the Stephenson Memorial Hall, Chesterfield. The new president for the year is Mr. M. H. Mills. The report showed that 25 new members had been admitted during the year, as against 28 the year before, the total membership being 349.

Photographic Society.—The forty-first annual exhibition of the Royal Photographic Society will open to the public on Monday, September 28. On the Saturday before there will be a private view, and in the evening a conversazione at which the president, Captain W. de W. Abney, C.B., F.R.S., and the council will receive the fellows, members, and their friends.

Whitworth Scholars.—The Department of Science and Art have issued the list of candidates successful in the competition for the Whitworth scholarships and exhibitions in 1896. The following secure scholarships of the value of £125 a year each, tenable for three years: Frederick C. Lea, Crewe; William A. Taylor, Crewe; Henry T. Davidge, London; John W. Hinchley, Lincoln.

Personal.—Mr. J. H. Belcher, F.C.S., who has been head master of the science branch of the School of Science and Art at Lincoln for over eight years, has been appointed headmaster of the Municipal Technical Institute and School of Art at Coventry. The committee of the Lincoln school has appointed Mr. A. E. Collis to be head of a new engineering department at the school. Mr. Clarence H. Creasey, a first-class honours man, and Queen's medallist, has been appointed instructor in chemistry.

Petroleum.—A vaporising petroleum lamp used in some building operations at Brompton exploded last week and killed a workman. At the inquest Mr. Gibson, who represented the London County Council, said this was the third case of the kind that had come under his notice in two years, and two had terminated fatally. The jury returned a verdict of accidental death, and added a rider to the effect that in future some person having a thorough knowledge of the lamps should be placed in charge of them.

Telephone Switchboards.—Mr. Dane Sinclair's paper at the Institution of Electrical Engineers on the subject of the working of a telephone exchange has been translated and published in full by the *Journal Télégraphique*, which is the organ of the Bureau International. In reference to the readiness of French writers to adopt foreign expressions, it may be noted that "jack" occurs once between inverted commas, after which both jack and spring-jack take their places in the text as regularly accepted French words.

Laying Mains.—The *Sheffield Daily Telegraph*, which ought to know, says that the Derbyshire carters always take their half of the road out of the middle. We note the fact, and if we should go driving thereabouts shall know what to expect. Our contemporary, however, goes on to complain of the local electric lighting company for adopting a similar line of policy, and laying their mains under the middle of the footpaths instead of at the side, with the result that pedestrians are driven off the path into the roadway whenever there is any work being done to the mains. Possibly, however, the company have a good reason for what they are doing.

A Curious Discovery.—In the course of the excavations at Shoreditch in connection with the electric light installation one of the workmen struck his pick into an old well, and had, it is stated, a narrow escape of going to the bottom of it, and finding himself in 7ft. of water. The well is situated a few yards from the Standard Theatre, close to the end of Holywell House, and it is possible that this is the well that gave the name to the spot. If that is so, it was connected with the old Benedictine Priory. The antiquarians, however, will have no chance of discussing the point, as the Vestry, for whom the work is being done, decided to have the well filled in at once.

Labour Troubles.—The notorious strike at Thorneycroft's owing to the standing dispute between the unions representing the boilermakers and fitters is stated to be in a fair way to be terminated. Up to the present arbitration has not been very successful in the matter. On the other hand, it appears to be decided that there is to be a very big strike or lock-out on the Clyde, which will probably also affect the Belfast and Sunderland engineering firms. What has been published lately with reference to the state of things in the pressed glass trade, though of less immediate concern, should demand consideration from everybody who complains of what might be British trade going abroad.

Directory of Railway Officials.—We have received from the Directory Publishing Company, 8, Catherine-street, Strand, Mr. S. R. Blundstone's "Universal Directory of Railway Officials for 1896." This is the second year of issue of this directory, and besides the corrections necessary to bring it up to date, the present volume contains additional particulars relating to the Prussian and Russian State lines, and various railways in Sweden, Cuba, Spain, and the United States. A note in the preface states that the "contents have been compiled entirely from official sources," and therefore they ought to be as correct as is possible in the case of information which has to be collected from every quarter of the globe.

Motorcarts.—The show at the Imperial Institute having been closed, about a dozen of the motorcarts from there have been taken to Wembley Park, where at any rate there is more space for them to display their capabilities. Though the new Act has been passed it is not yet in force, as some people have found to their cost, and it has been complained of that there was great difficulty and trouble in getting motor vehicles down to Wembley, as the police refused to allow them to be driven there in the daytime. This seems eminently absurd, as nothing less than an immediate summoning of a special session of Parliament can prevent them running anywhere after November 15 next. Until then, however, the usual official opposition to anything that is new will have still to be reckoned with.

Nuremberg Exhibition.—An exhibition almost entirely devoted to the national interests of Bavaria has been open this summer at Nuremberg. The exhibition is in a park on the outskirts of the town, and access is gained to it by well-appointed tramways, particularly an electric line, on which the tramcars run at about eight miles an hour. The chief buildings are the industrial building and the machinery hall, but there are numerous pavilions

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scattered about the grounds. The main machinery hall covers an area of 9,300 square metres, and there is only one line of shafting, driven direct by a steam-engine. The hall is crowded with machinery, and much of it is driven by electromotors, either directly or by belting, and besides this a great deal of the moving machinery in other buildings is driven electrically.

The Mining Engineers.—The Federated Institution of Mining Engineers, who have chosen Cardiff for their seventh annual general meeting, appear to intend to combine business with pleasure as much as possible. The meeting will open at noon on Tuesday, September 15, at the rooms of the South Wales Institute of Engineers, Park-place, when papers will be read. Then, on September 16, special arrangements have been made for visits to the Deep Navigation Colliery and the Great Western Collieries, and on September 17 to Symond's Yat, Tintern Abbey, and the Dowlais Steelworks. By the courtesy of the executive council of the Cardiff exhibition, members may obtain tickets admitting them to the exhibition for the week at 1s. each, and it is probable that on both Tuesday and Wednesday the whole of the members will dine in the large dining-room at the exhibition.

The Sussmann Lamp.—At the statutory meeting of the Süssmann Miners' Lamp Company, on Monday, there were quite a quantity of the company's lamps on view. They consist of a small 1-c.p. incandescent lamp, with a reflector placed inside a glass globe protected on three sides by a cover, and mounted on the top or lid of the battery box, the latter forming the stand. The connection to the terminals of the battery is by flexible leads and plug contacts. It is proposed to supply the lamps to the pitmen alight, and with the lids locked or sealed down, any arrangement for switching off being considered unnecessary, as the lamp will be in continuous use up to the end of the shift, when it is returned. Though provided with a hook of the usual pattern, the lamp may be placed on its side or upside down, and, according to the statement of the chairman of the company, will run for 12 hours, or on an emergency longer, but, of course, if its normal period is exceeded the power of the light falls off.

Budapest Exhibition.—The exhibition which has been held this summer at Budapest as part of the celebrations of the millennial anniversary of the kingdom of Hungary occupies a park to the north of the town, and is an affair of some very considerable magnitude. A narrow-gauge electric tramway on the overhead conductor system runs from end to end of the grounds, and access to the exhibition from the centre of the town is provided for by numerous tramways and by the electric underground railway. There are nearly 16,000 exhibitors and 160 separate buildings. The second largest building is the machinery hall, covering 12,000 square yards. The bulk of the machinery in it is agricultural, agriculture being the staple industry of the country. Messrs. Ganz and Co., of Budapest, have a building to themselves. Their most striking exhibit is a turbine intended to drive dynamos for power transmission up to 800 h.p. Around it are different sorts of electric motors and other machinery.

Telegraphic Interruptions.—In the official list published by the Berne *Journal Télégraphique* of August 25 the list of cable interruptions in which communications had not been restored by that date begins with the old Brest and St. Pierre cable dating from 1893, which might surely now be omitted. The others are the Puerto Plata and Martinique cable, which failed on December 19 last, and the African line beyond Mazoe, March 11. There then follow the Amazon Company's cable beyond Monte Alegre, May 4 ; the Cartagena and Barranquilla line in Colombia, July 4 ; the Salisbury and Umtali line to Beira, July 11 ; the Ecuador lines to Quito and other towns, August 11 ; the Radde and Khabarovka line in Siberia, August 19 ; the Pará and Maranham cable, August 6 ; and the Zanzibar and Mombassa cable, August 23. Communication with Bissao and Bolama was restored on August 5, after six days' interruption, and between Shanghai and Nagasaki after more than a week's cessation on August 2. There were short interruptions of the Saigon and Bangkok and of the Sheik Said and Hodeida lines. The Gibraltar and Tangiers cable, which failed on July 28, was restored on August 12, and besides two short interruptions on Siberian lines the only other noted is the failure of the Moulmein and Bangkok line between July 28 and August 7.

Undecided.—Matters seem very much at a deadlock in Glasgow with reference to the proposed adoption of electric traction for the tramways. At the usual fortnightly meeting of the Corporation Tramways Committee, the remit from the Town Council for further information regarding the question came up anew for consideration. Mr. Oatts proposed and Mr. Martin seconded that the papers lie on the table, and that the manager be instructed to get further information. Mr. King proposed and Bailie Thomson seconded that the matter be remitted to the Motor Committee for further consideration and to report. On a division, nine voted for the motion and nine for the amendment. The convener (which we believe is the Scottish equivalent for chairman) again declined to give his casting vote, so no conclusion was come to. The Council had really better decide the matter itself or enlarge the committee. The question of whether the committee want further information or not is not a very serious one anyway; too much knowledge is usually less dangerous and expensive than too little. Nor would one like to suggest that, as the committee find the balance of advantages so near that they are unable to decide one way or the other, they should toss up for it, and so get a decision one way or another. Such a course would as ill become the dignity of a committee of the second city in the United Kingdom as does their present attitude of irresolution.

Engineers in Manitoba.—Under the influence of the Canadian Society of Civil Engineers, the Manitoban Provincial Government has passed an Act which, among other provisions, contains the following: "On and after July 1, 1896, no person shall be entitled within this province to take or use the name and title of 'civil engineer,' or any abbreviation thereof, either alone or in combination with any other word or words, or any name, title, or description implying that he is a member of the said (Canadian) Society of Civil Engineers, or act as engineer in laying out, advising on, constructing or superintending the construction of any railway or public work, or any work upon which public money is expended, the cost of which shall exceed 500dol., unless such person is a member of the society hereby incorporated and registered as such under the provisions of this Act, or unless he is a duly qualified civil engineer, and entitled to use the title of civil engineer by virtue of some statute in force in this province, or by the authority of some institution of learning in this province having authority to confer degrees in civil engineering, or unless he has been practising as a civil engineer in this province at the time of the passing of this Act, or unless he is a member in good standing of some institution of civil engineers in Great Britain and Ireland, or of some national society of civil engineers of good standing in any foreign country." The provision in the last lines would seem to open the door to endless evasion,

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Quite apart from the question of whether legislation of this character is desirable, we should have thought that any attempt to restrict the use of the letters C.E. in Canada was a matter for the Dominion rather than the provincial Governments.

Electric Stone-Crusher.—A stone-crusher driven by an electric motor, which has recently been installed at Peterboro in Canada by the Royal Electric Company, is described in the *Canadian Architect and Builder.* The crusher is used by Messrs. Corry and Laverdure, the contractors for the construction of the Trent Valley canal, to crush all stone required for that section of the canal, and the plant is said to be the first of the kind and the only one in commercial operation in Canada. The current to operate the stone-crusher is transmitted from the station of the Peterboro Light and Power Company, a mile distant. The motor plant consists of a 50-kilowatt alternating-current synchronous motor, with its exciter, and a 5-h.p. starting motor. The alternating current is taken by the motor directly from the transmission line at 1,000 volts. The stone-crusher is belted to one end of the shaft of the synchronous motor. To the other end are belted in tandem the exciter and starting motor, the attendant on the stone-crushing plant being informed as soon as the synchronous motor is in step with the alternator by a lamp going out in the usual manner. The plant was started in June, and it is stated that the crusher has been successfully doing its work every day since. It has been put to the utmost test; the greatest possible loads have been put on; the crusher has been jammed full of the hardest stones obtainable; the greatest variations possible in load, from nothing to the extreme capacity of the crusher, have taken place rapidly, but no variation in speed occurred, the synchronous motor meeting every demand upon it without change. Under these circumstances it is hardly surprising to find it added that Messrs. Corry and Laverdure express themselves as pleased with the operation of the plant.

The Junior Engineers.—At the summer meeting of the Institution of Junior Engineers the district visited was Edinburgh, Glasgow, and the Clyde. The programme, as already given in these columns, was duly carried out, and we last week noticed the visit of the members to Dumbarton. On the following day (Friday) various works were inspected at Glasgow and Govan, and in the evening the summer dinner of the institution was held at the Alexandra Hotel, Glasgow. After the usual loyal toasts, the president gave "The University of Glasgow,' which was responded to by Lord Kelvin, vice-president of the institution. To "The Institution of Engineers and Shipbuilders in Scotland," proposed by Mr. W. B. Clarke, Sir William Arrol replied. "Industrial Scotland," given by Mr. H. B. Vorley, was responded to by Mr. James Riley, and "The Institution of Junior Engineers," which was proposed by Provost Garvie, of Dumbarton, was acknowledged by Mr. H. J. Young. The concluding toasts were "The President," given by Mr. A. Anstruther Thomson, and "The Chairman and Vice-Chairman," proposed by Mr. W. E. Lilley. During the evening, in recognition of his efforts in promoting and carrying out the arrangements of the meeting, a presentation was made to the secretary, Mr. W. T. Dunn. On Saturday morning the Dawsholm Gasworks were visited, Mr. William Foulis receiving the party. Other members visited Messrs. Sir W. Arrol's works and the sewage precipitation works, which were opened to their inspection. The Glasgow electric light station was available for visiting in the evenings. Altogether the meeting passed off most successfully, and the occasion distinctly indicated the advantages which the younger members of the profession have the opportunity of enjoying under the auspices of this institution, the membership of which is now over 450.

Scientific Education.—The publication of Prof. Ostwald's views on this subject has produced a letter to the *Times* from a "Chemical Manufacturer," who says that there is a by no means small class of manufacturers in this country who have for years recognised the necessity of employing highly-trained chemists in their works, and this demand has, with few exceptions, to be met by recruiting talent from Germany or Switzerland. This is not done from choice, as foreign chemists will not accept posts in England unless they are much better paid than they would be in their own country, and they have a tendency to return to their native shores. As reasons for the lack of well-trained English chemists, it is suggested that the money available in this country for higher educational purposes (scientific) is spent in establishing and maintaining a large number of unsatisfactory technical schools, instead of a small number of good colleges. The individual schools are, consequently, often insufficiently equipped, and in most cases the professors are badly paid, the result being that some of the best men refuse to enter the teaching profession at all. Moreover, there is practically no State aid for higher education; whereas, in a German or Swiss university, students only pay one-third to one-half the actual cost of their education, the State providing the remainder. Finally, the whole system of higher scientific education in England seems to have been developed in the wrong direction for several decades. To establish technical schools in every borough of the kingdom may have its advantages, and is possibly an ideal system. But what we want above all is to develop a practical system first. Ask the average chemical manufacturer, be he Englishman, German, or Swiss, whether he is anxious his workmen, even his foremen, should know something about science. He will tell you that he wants workmen who carry out his instructions, and that the smattering of doubtful science his workmen may have acquired at the average technical school is worse than useless. What we must strive for is that an Englishman may have more opportunities of acquiring at home, at reasonable cost, as sound a higher scientific training as he can now obtain abroad. This will enable him to occupy with greater success the leading position as manager in a chemical or similar works, or to further by pure research work the particular industry in which he is engaged. To this end it seems of primary importance that the limited funds available for higher scientific education in the United Kingdom should be devoted to a relatively small number of the best colleges. This would be productive of better results than if such available funds are frittered away on a multitude of technical schools which, with the relatively small means at their disposal, cannot be equipped and managed otherwise than indifferently. Without altogether endorsing these views, it must be confessed that there is unfortunately a certain amount of truth in them, and the case might have been pressed still further if reference had been made to the deplorable waste of money on what passes for "technical" education with many country boroughs and county councils.

An American View.—Under the title of the "Era of Extravagance in the Electrical Business," Mr. Burton E. Greene has contributed an article to the New York *Engineering Magazine*, the general drift of which is to show that, though the electrical business in America has been somewhat unsatisfactory in the past, now, "after 16 years of expensive and misguided struggle, of fever and unrest,

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the business has touched rock bottom, and can take its place among the stable and substantial industries of the country." Mr. Greene does not think much of the prospects of the new lamps that Mr. Macfarlane Moore, Mr. Edison, and Mr. Nikola Tesla have invented or are going to invent. In fact, Mr. Tesla says he would hold gas or electric lighting stock, if he had any, for at least a year or two longer. In spite of this declaration that he is not going to upset the electrical world for the next 24 months, we are inclined to think that of the three men Mr. Tesla is on the whole the likeliest to produce something practical. Mr. Greene does not seem to approve of research work from the money-making point of view. That we can very well understand—it so very much depends on the qualifications of the experimenter. In reference to what follows, it must be remembered that a "silver" policy has a direct as well an indirect effect on all work carried on subject to a statutory maximum charge, for instance, in the case of an electric tramway "franchise" with fixed fares. Mr. Greene's final conclusions, then, are as follows: "Expenses for experimental work have not been entirely eliminated. They never can or ought to be eliminated from any progressive trade depending upon invention for supremacy. But they have been reduced to less than one-tenth of the average 10 years ago. Extravagant salaries are no longer common. They have been very generally adjusted to meet changed conditions. There is no longer a scarcity of men with a knowledge of electrics. In fact, the market is becoming overcrowded. All along the line sensible economies have been put into practice, and the expenses of doing business are nearly as low as in any of the old-established industries. District managers and district offices, which were in reality so many distinct business establishments where extravagance reigned supreme, have been abolished, without any great diminution in sales. Comparing the present situation with any other period since 1880, there is nothing but encouragement for those engaged in electrical manufacture. They are offering for sale what the public must buy. The demand is as certain as the demand for ploughs or farm wagons. The boom period has passed for ever. The industry will no longer suffer from so many diseases peculiar to itself. It will thrive as general business thrives, and be less susceptible, perhaps, to a general depression than almost any other. The chief danger to-day is that which threatens alike every commercial enterprise in America, from the railroads to the farmer, even to the individual labourer — the danger of an unsettled financial policy. Of the ultimate triumph of the gold standard there can be no question. Meantime, the evidence of financial heresy spreading through large sections of our country cannot be ignored. With this question finally settled the profitableness of the electrical trade would be beyond question."

Light Units.—The Geneva Electrical Congress has resolved on a system of photometric units, and it only remains to get all the rest of the world to use them. The units are the French units, and were pretty strongly criticised by the Germans and only weakly supported by the Italians, so that, England and America being unrepresented in the discussion, it can hardly be said that the system is at present certain of adoption by all the principal civilised nations. The matter came up on a report on the subject by Prof. André Blondel, who, however, was unab'e to be present. The units are not numerous, so that the Latin and Greek dictionaries will supply designations enough without taking random dips into a bag containing all the names of eminent discoverers and experts in the art of lighting from Prometheus downwards. These worthies therefore still remain in obscurity among the other shades, and Prof. Ferraris had no need to fight them with a phantom archimedes and torricelli, as he did in the case of the magnetic units. Nevertheless, the "pyr" was judged too recondite for the multitude, and the "bougie decimale" was adopted, a quantity named apparently on the *lucus a non lucendo* principle, because it is somewhere about one-twentieth instead of one-tenth of the Violle standard. However, it must be admitted that it would be a dull fire or a very small one that only gave one pyr. The new quantities have Roman and Greek capital letters assigned to them which clash with those already in use in electricity. The new units are [I], for intensity (the German expression "strength of light" is better), the bougie decimale, and for [Φ], the flux of light, the lumen. For [E], illumination, the lumen per square metre. This quantity will be a decimal in most cases of outdoor lighting—in measuring moonshine, for example—though it ought to have a fair amount of digits in the daytime. The name of this unit is the lux. The other two units have at present no special names: they are for [*e*], brightness, the bougie per square metre and [Q], quantity of light, the lumen-hour. Exception was taken to the unit of brightness, but when you have to measure anything between the brightness of a glow worm and a glow lamp you must have several digits somewhere. So far, then, there was no great trouble; it was about the standard that the disputes occurred. The report preferred the Hefner amyl acetate lamp to the Vernon Harcourt pentane one. The American standard of incandescing carbon at a given temperature was not practical, and the Violle standard of melting platinum was recommended as the theoretical one. All the Germans objected to this on the reasonable ground that it was absurd to gauge a fair instrument like the Hefner lamp by an utterly uncertain standard, Dr. Köpsel saying that at the Reichsanstalt, using either the oxy-hydrogen flame or the electric current for fusion, they were unable to get the platinum standard certain within 25 per cent. It was ultimately determined, however, by a majority that the report should be adopted, and the bougie should be represented "provisionally" only and for industrial requirements by the Hefner lamp. It may be suggested that as the lights in ordinary use are of different colours, and it is certain that the relative intensities of light of different wave-lengths is not by any means the same for all persons, it will be necessary before a system of photometric units can attain theoretical perfection to define a standard eye.

Electrical Congress at Geneva.—The International Electrical Congress at Geneva mustered about 250 members, but, as was expected, it was not quite so international as it might have been. Among the members the French and Italians appeared to predominate, but so far as the papers and discussions were concerned the German influence was strong. Our Institution of Electrical Engineers sent no delegates, and though Prof. Bradley came from the American Institute of Electrical Engineers, it may be said that the English-speaking countries and their work were practically unrepresented. We published in advance the programme of the subjects discussed. The decision of the congress on the question of photometric standards forms the subject of another note, and though we may possibly refer at a future date to some of the papers read, at present a very brief notice of the proceedings will be sufficient. They began in German with a report by Dr. Wietlisbach, of Berne, on the disturbances in telephone lines produced by strong currents, and were continued by Dr. Palaz in French. The report cannot be summarised very briefly, but there was little

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novel in its recommendations. Prof. Hospitalier introduced the subject of magnetic units, and proposed the adoption of the system of units settled by the American Institute of Electrical Engineers in 1894, including their application of the names Gauss, Weber, Gilbert, and Oersted. Pros. Ferraris objected, and started off a burlesque system of units of pressure and density entirely of his own composition. Mr. Gisbert Kapp found no difficulty in dealing with millions so long as they were only millions of lines of force (or units of brightness), and so on with the others—in fact, Prof. Kovalevski was about the only man who backed up the proposition. Ultimately, in order to avoid a direct negative, on the motion of Prof. Mengarini, of Rome, the congress suspended the debate without any resolution being passed. Consequently, so far as the congress is concerned, it is open to everyone to go on discussing $4\ \pi/10$, and the rest of it. It looks as though the Fates intended to deny to Weber the immortalisation of his name as a unit after all. Perhaps the system will be more lucky that leaves it out. On the subject of power transmission there was a paper by Mr. André Blondel, which dealt with wattless currents. Most of the known remedies and palliatives for these were referred to, and the conclusion arrived at was that further research was required on the subject. The discussion went off into mere questions of nomenclature, the name "wattless" being apparently more objectionable to the professors than the actual current. Prof. Ferraris would have none of it in Italian. The French speakers were divided on the subject. If a foreigner may express an opinion after, such un-French-looking words as *self-induction* and *spring-jack*, *dewatté* may very well pass. The expression was made in Germany, like many other things, and adopted in England, because it could be brought over straight away without trouble and was found useful. It is a pity that it has not proved possible to do the same with *drehstrom*. The congress then got back to business, and Mr. René Thury showed that there was a good deal to be said for the use of high tension continuous instead of alternating currents for power transmission. In one way or another this last subject occupied the rest of the time of the congress. There was nothing strikingly novel, but the matter may possibly be recurred to in a future note. Prof. Raoul Pictet's lecture on low temperatures and cathode rays was somewhat disappointing considering the eminence of the author.

The British Association.—The meeting of the British Association on the 23rd inst. at Liverpool will be a revisit to that city after an interval of 26 years. The local secretaries, Prof. Herdman and his colleagues, Mr. Isaac C. Thompson and Mr. W. E. Willink, have been working hard to make the meeting a success, and the preparations are now practically complete. The reception-room and general offices will be at St. George's Hall in the centre of the city, a few yards from Lime-street Station. St. George's Hall has just been redecorated and provided with electric light. The Geography Section will occupy the concert-room of the hall, and three other sections (Geology, Anthropology, and Mechanical Science) have been given rooms in the adjoining Public Museum and Walker Art Gallery. The section of Economics will be at the Town Hall, while the remaining sections—Physics, Chemistry, Zoology, Physiology, and Botany—will be in the laboratories and lecture theatres of University College, over half a mile from the reception-room. A tramway route, however, leads from the reception-room to the corner of the college, and arrangements will be made for omnibuses in addition to the tramcars. The Philharmonic Hall has been engaged for the president's address and the two evening discourses by Dr. Elgar and Prof. Flinders Petrie. Prof. Fleming's lecture to the working classes will be given in the Picton Lecture Hall. The first conversazione, given by the Earl of Derby, as Lord Mayor of Liverpool, will be held in the Town Hall, and the second, that arranged by the local committee, will be in the Museum and Walker Art Gallery. The large amount of space available will enable short lectures, demonstrations, and exhibitions to be a prominent and attractive feature of this conversazione. The subject of the presidential address by Sir Joseph Lister has been somewhat jealously guarded, but it may reasonably be expected to deal with the biological rather than the physical side of science. The president of Section A, Mathematical and Physical Science, is Prof. J. J. Thomson, F.R.S., of Cambridge, who in his address will deal with the teaching of physics, Röntgen rays, the passage of electricity through gases, and the movement of the ether. In Section G, Mechanical Science, Prof. Douglas Fox will deal in his address with the advances in mechanical science and engineering, especially in connection with Liverpool, during the last 25 years. In this section Prof. Mengarini has promised to give some account of the electric light and tramway systems of Rome. Mr. E. W. Anderson will have some notes on electric cranes, and Mr. W. A. Preece will speak of a test for incandescent lamps. Mr. W. W. Beaumont will discuss "Why railway rails break." Prof. Hele Shaw will deal with engineering laboratory apparatus, and his paper will be followed by a reception and demonstration in the Wallace Engineering Laboratory. Motorcarts will be dealt with by Mr. A. R. Sennett, and it is expected that a number of horseless carriages will be shown in operation. Three important reports will be presented to this section—the report of the Committee on Tides, the report of the Committee on Small Screw Gauges, and the report of the Committee on the Standardising of Instruments in Engineering Laboratories. Dr. Ludwig Mond, F.R.S., will preside over Section B, Chemistry, and in his address will deal with the history of the manufacture of chlorine and the influence of the progress of pure science upon its development. In this section Prof. Ramsay will read a paper on helium, and there will be a number of other communications on helium and argon. Prof. Norman Lockyer will read a paper on "The Synthesis of the Elements," a title which, so far as we know, is still somewhat premature, and it is expected this will lead to a discussion, in which Mr. Crookes and others will take part. There are interesting papers to be read in the other sections, but these, of course, are on subjects of less immediate concern to most of our readers. The metric system comes up in the Economics Section. Pithecanthropus, which the general public will insist on miscalling the "missing link," will come up under anthropology, while Dr. Gaskell, in the new section of physiology, will bring out a new theory as to the origin of the vertebrates. He is going to explain quite a quantity of rudiments that have puzzled biologists, but it may be safely said that those competent to understand and criticise his hypothesis will be few and select. The Geographical Section is, of course, the region of "lions," but it is understood that the attempts to capture Dr. Nansen for it have failed. Finally, it may be said that the Publications Sub-Committee have drawn up two books, which will be presented to members; the first is a scientific handbook to Liverpool and the neighbourhood, containing articles on the history and antiquities, the geology, the entomology, marine biology, botany, the vertebrate fauna, climate, river, and tides, docks, and other engineering works, trade and commerce, and the chemical industries. The second book is a complete guide to the various excursions.

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SOUTH SHIELDS ELECTRICITY WORKS.

The Municipality of South Shields has always regarded electricity with a favourable mind, and the ratepayers will now begin to reap the advantages which an enterprising foresight on the part of their representatives in past years made possible. Up till the last few years, the question as to whether it was advisable for cities and towns to take up the position of suppliers of electricity, or whether it was advisable to let private companies start the undertaking, was a question which considerably exercised the minds of the elect of the ratepayers; but among the corporations who wisely decided upon what was then the bolder policy was that of South Shields. Having decided to have an electricity supply is one thing, and having obtained it is quite another. The South Shields electric lighting provisional order is dated 1891: the inauguration of it has now to be dated 1896. The history of the movement is brief and unsensational, but it illustrates well much of our civic life of to-day—the quiet, steady plodding away at detail after detail until a successful result is reached. In 1893, the matter may be said to have been fairly started. In that year the Corporation obtained a report from a gentleman living in the neighbourhood, and on that report, a committee was appointed—the Electric Lighting Committee. A consulting engineer was not engaged, inasmuch as the committee contained two well-known Tyneside engineers of great experience—Alderman Rennoldson and Alderman Eltringham. North-countrymen are nothing if not practical and 'cute, and their idea of a consulting engineer was a man who might be of a very scientific turn of mind, with an overwhelming desire to conduct interesting experiments at the expense of the Corporation. Wherefore they advertised straight away for an electrical engineer who would design a system and draw up all specifications. The result of that advertisement was that Mr. Joseph A. Jeckell, A.I.E.E., was appointed borough electrical engineer in November, 1893, and he has achieved success, not only as an electrical engineer, but as a man who is able to specify what is really wanted and to see that he gets it. Such work can only be the result of experience, and Mr. Jeckell gained a great deal of his experience in two very good schools—London and Manchester. Having appointed an engineer, the committee set about finding a site. They first of all rather fancied one in the centre of the borough which was available at the time, but after matured deliberations this was discarded. Then they heard of the present site, which was called Black's Old Foundry, West Holborn, and eventually succeeded in purchasing it at a cost, including legal expenses, of £4,600. The site is an admirable one. It is situated on the river's edge, and is also to all intents and purposes as near the centre of the borough as it is possible to be. When one considers that South Shields has a population bordering on 90,000, it will be understood that this fact is of considerable importance. The area of the site is about 2,000 square feet, and there is a good river frontage. There is room for extensions large enough to accommodate all the plant that South Shields is ever likely to require. The whole of the plans and specifications were got out by Mr. Jeckell, but it was not till February, 1895, that the contracts were let, and then the Board of Trade and the Local Government Board had to be dealt with, so the work of laying cables, clearing the site, and rebuilding was not commenced till June, 1895. Permission to borrow £28,000 had previously been obtained.

Now the works are finished (until such time as extensions are necessary) and the plant is laid down, and, with the exception of a few details, everything is very shipshape and satisfactory. The buildings, which are from Mr. Jeckell's designs, have no pretensions to great architectural beauty, but they look as if they mean what they do mean—business. They are chiefly of red brick, solid and capacious. Utility was evidently the key to Mr. Jeckell's design. Not an inch of space is wasted, as every part is adapted to the machinery to be housed. That is the secret of successful designing. The buildings were erected by Messrs. W. and R. Brown at a cost of £3,124. 15s., and the estimate got out by Mr. Jeckell was for £3,100, which is something to be proud of. Mr. Fred. Rennoldson, of South Shields, was clerk of the works, and he got out the bills of quantities in the first instance.

The Market Place, South Shields.

The system of supply adopted is the high-tension alternating one, with automatic transformers buried in the street. These supply low-tension mains in the busy parts of the town, but in some scattered residential districts transformers will be provided for each consumer. The area covered can be seen in Fig. 1, which also shows the position of the supply station relatively to the area in which mains are now laid. The sides of the streets along which low-tensions mains are laid have been shaded in the plan. As will be seen from this, there are four transformer stations at present in the district, and the high-tension mains embraces a much larger area than the low-tension. It was originally intended to complete high-tension ring through Claypath-lane, but now these mains are carried further out, as shown, so that a good residential district can be tapped.

Steam Generating Plant.

The contract for this part of the work and including the necessary steam-pipes, etc., was placed with the noted firm of Black, Hawthorne, and Co., of Gateshead. The two

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boilers are of the marine type. By the courtesy of the above firm we are able to give the fully detailed elevations, Figs. 2 and 3, which show every leading dimension. These boilers are each guaranteed to evaporate 5,000lb. of water per hour at a pressure of 160lb. The following are the areas of the heating surfaces of these boilers: the furnaces and combustion chambers, 197·34 square feet; the back tube plates, 23·54 square feet; the front tube plates, 16·12 square feet; 118 3½in. outside diameter tubes, 743·00 square feet; total heating surface, 980·00 square feet. All the plates, rivets, and stays in these boilers are of steel. The tubes are wrought iron, and are attached to the tube plates in the manner shown in Fig. 3. All the rivet holes were drilled, and those in the shell were drilled after the plates had been bent. The working pressure of these boilers is 160lb. per

Feed-Pumps.—These were included in the contract given to Messrs. Henry Watson and Sons, of the High Bridge Works, Newcastle-on-Tyne. There are two feed-pumps for the boilers, of the duplex double-acting type, each capable of feeding both boilers simultaneously. The pumps have 4½in. diameter steam-cylinders, 3in. pump-chambers, and work with a 6in. stroke. They are arranged side by side, and draw their feed supply from a cast-iron hot-well, of ample capacity, placed near. They exhaust into the same hot-well, which was also constructed by Messrs. Watson and Sons. These pumps and their connections are well arranged in the boiler-house, and work smoothly and well. The above-named firm have also supplied a compact and well-arranged plant of condenser circulating pumps, and auxiliary air-pump and condenser, etc.

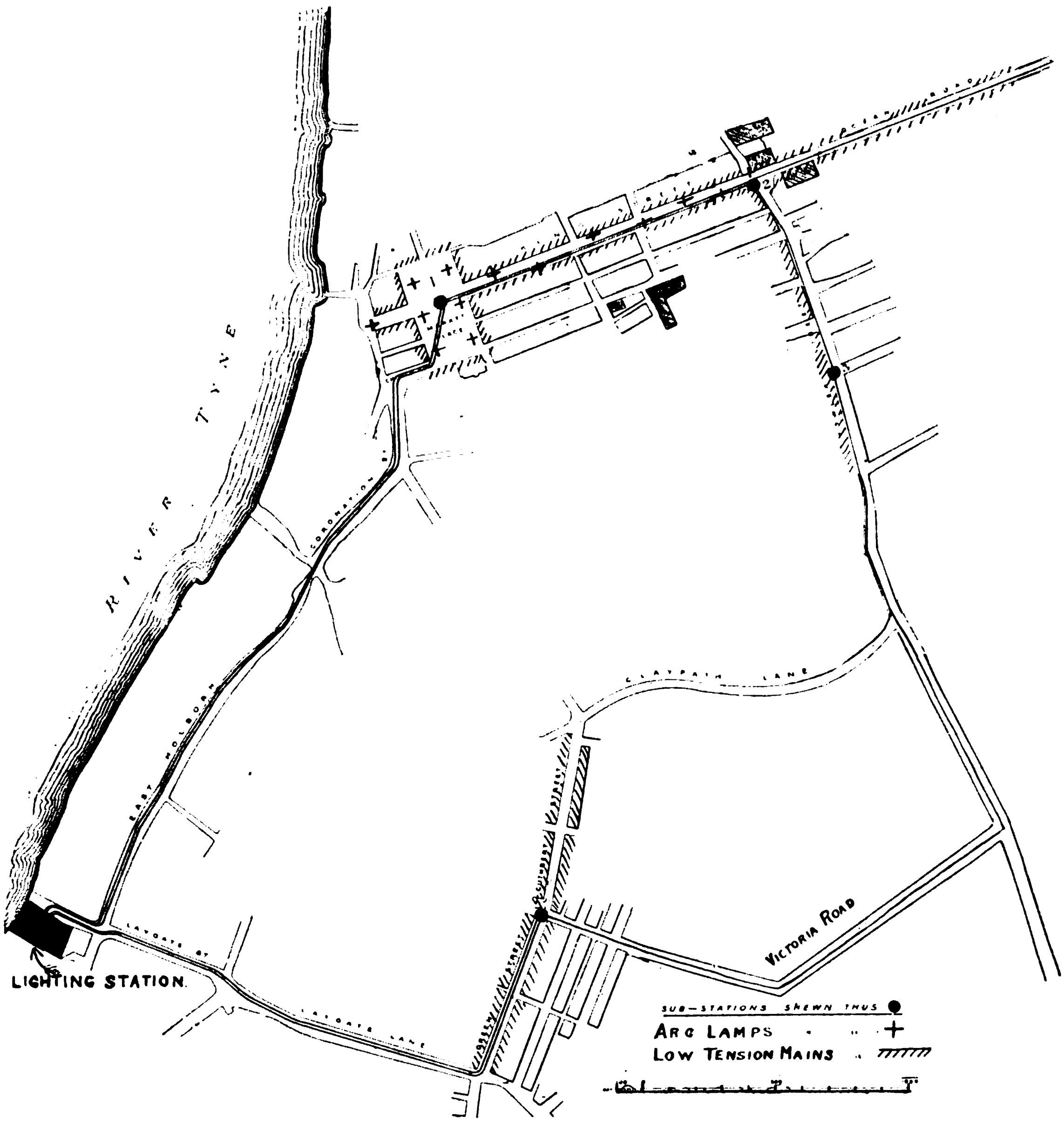

FIG. 1.—Plan of Streets in South Shields, showing High-Tension Mains.

square inch, but they were tested up to 320lb. per square inch after being placed in their seatings. They were built under the inspection of Lloyds, to Mr. Jeckell's specification, and have been certified by them after final examination. The makers have also guaranteed that these boilers shall evaporate 10lb. of water from and at 212deg. F. per pound of good Northumberland coal burned in the furnace when steaming at the guaranteed rate of 5,000lb. of water per hour. Fig. 4 shows details of the riveting of a horizontal joint in the rings, and the following details are of interest in connection with this illustration: The inside butt straps are ¾in. thick, and the outside butt straps ⅞in. thick. Also, taking the strength of the solid plate as 100, the strength of the plate between the holes then is 87·13, the strength of the rivets 93·93, and the strength of the plate on the 4¼in. pitch line 93·04.

Duplex Circulating Engines.—Adjoining the main engine-room is the pump-room, in which are placed the two large direct-acting duplex pumping engines. Each pump has 7½in. diameter steam-cylinders, 10in. pump-chambers, and works with a 12in. stroke. Each is capable, when supplied with steam of 160lb. per square inch and running at normal speed, of delivering 16,000 gallons per hour into a large cast-iron tank (constructed and erected by Messrs. Watson) overhead. This tank practically forms the roof of the pump-room, and from it the water flows to the jet-condensers by gravitation. From the illustration (Fig. 5) it will be noticed that these circulating engines are of neat design, and that the valves and steam-chest are all accessible from the front. The engines work evenly, and without any of the kick or jar sometimes found in pumping engines of this type. The auxiliary air-pump is placed

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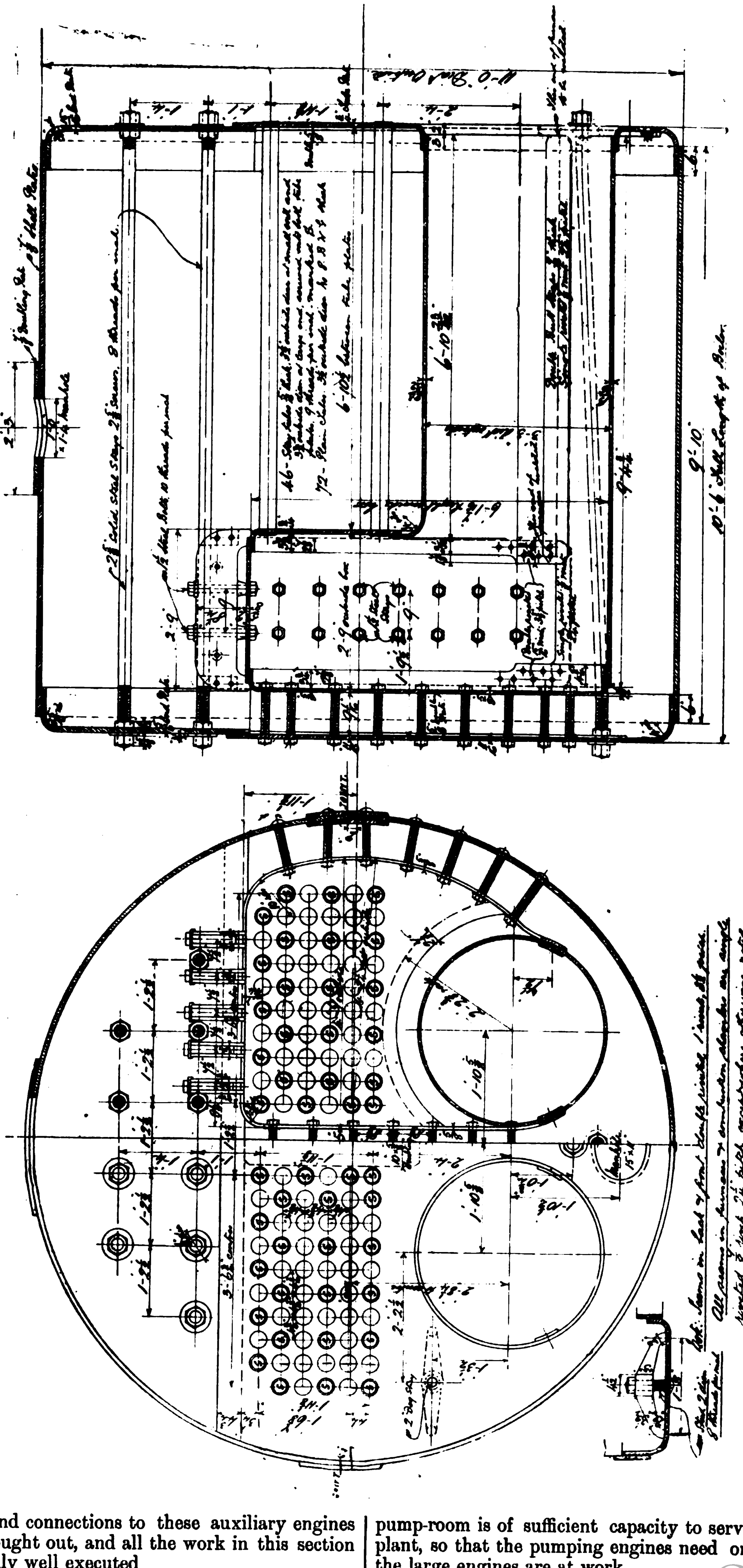
in the main engine-room, and carries a small condenser. It works in connection with one of the main engines. The system of pipes and connections to these auxiliary engines has been well thought out, and all the work in this section seems to be equally well executed



FIGS. 2 AND 3.—Sections and End Elevation of the Boilers Used at South Shields.

In designing this part of the plant the engineer has thought of labour economy. Thus, the tank above the pump-room is of sufficient capacity to serve the light-load plant, so that the pumping engines need only be run when the large engines are at work.

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ENGINE-HOUSE PLANT.

The whole of the generating machinery and the switchboards were included in Messrs. Ferranti's contracts. The engines were supplied under a sub-contract by Messrs. J. and H. McLaren, of the Midland Engine Works, Leeds. In specifying his requirements for the engines we understand that Mr. Jeckell recognised the importance of economy at light loads. In consequence, great attention has been paid by the makers to this point. In all, three engines have been supplied—one for day load, and two larger ones for taking the main load. The larger engines are triple-expansion and of the surface-condensing inverted cylinder type, similar to the three supplied to Oxford in 1892, which have been so successful in giving economical results. The makers are justly proud of the repeat orders they have received in consequence. The two engines at South Shields are used to drive 100-kilowatt alternators; have cylinders respectively 9⅛in., 14¼in., and 22½in. diameter, and the stroke is 24in. The crankshaft, which is a three-throw, is coupled direct to the axle of the alternator by means of a flanged coupling solid with the shaft. The distribution of steam is controlled by McLaren's patent automatic expansion governor, acting on balanced valves, in which the friction is almost entirely done away with. By means of this governor the speed can be controlled to within 2 per cent. up or down, notwithstanding any variation

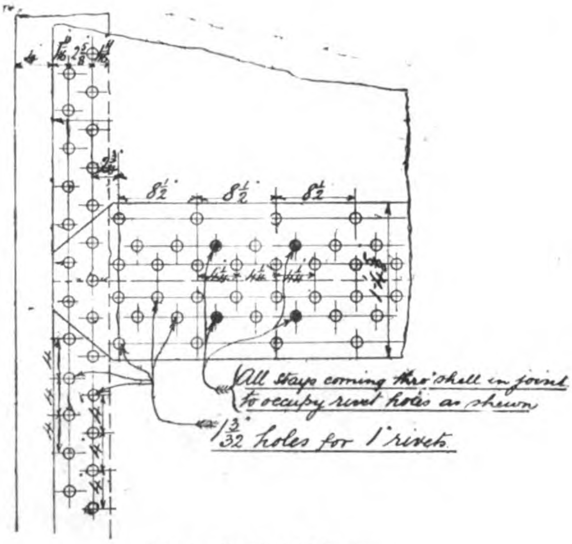

FIG. 4.—Details of Riveting.

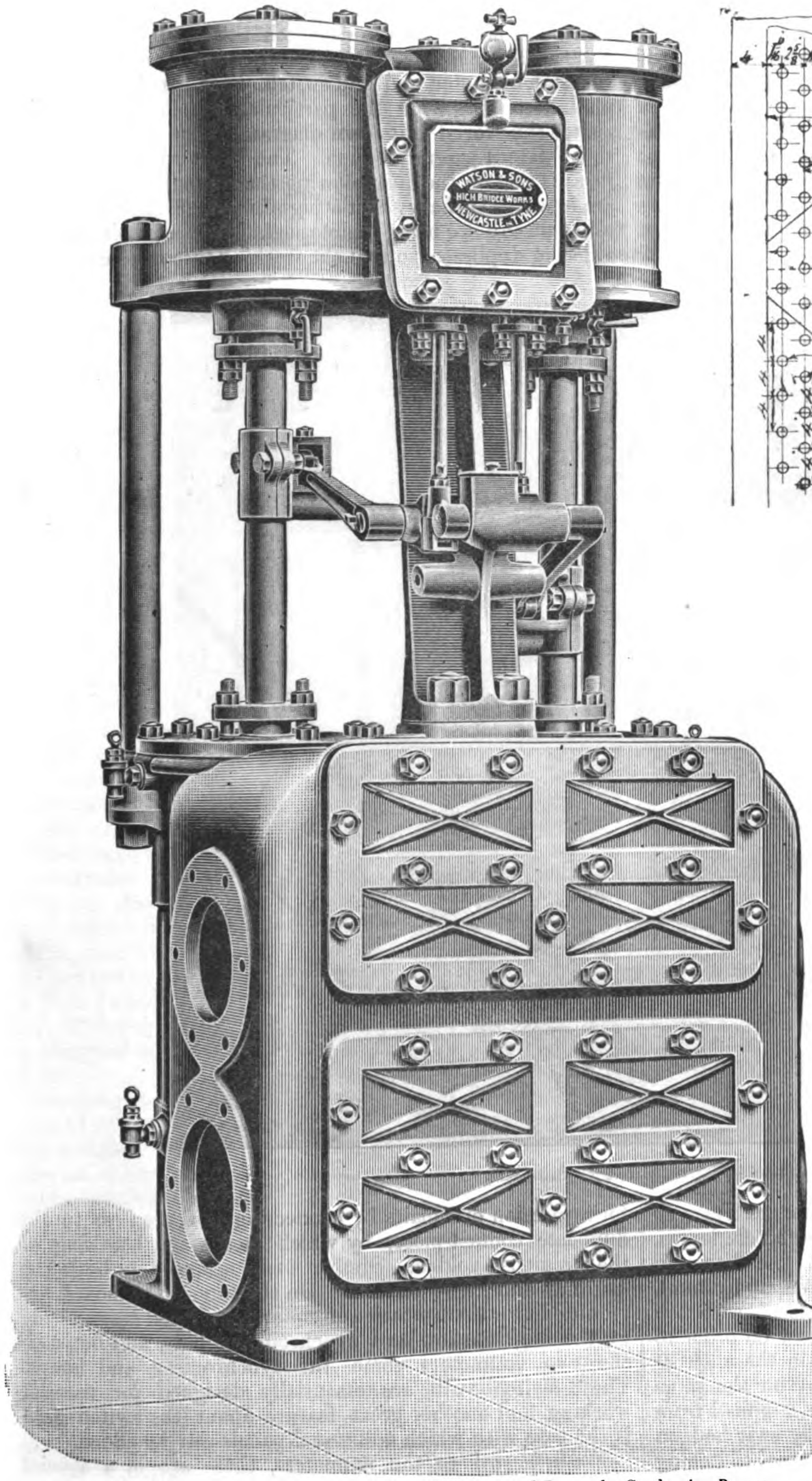

FIG. 5.—View of the Duplex Direct-Acting Engines and Pumps for Condensing Purposes.

in the load. The speed of the engine can also be increased or decreased from 5 to 10 per cent. above or below the normal by means of a simple speeding gear, whereby the number of revolutions can be varied while the engine is running, to suit the requirements of the moment. Parallel running can thus be easily secured, as the three-throw cranks, giving six impulses per revolution, give a far steadier turning moment than can be obtained from any single or double crank engines. All the cylinders and covers are properly jacketed and efficiently drained. These engines were tested at the engineer's works by Mr. Wilson Hartnell, of Leeds, and Mr. J. A. Jeckell previous to being delivered, and the following good results were obtained: the mechanical efficiency of the engines was found to be 94·2 per cent.; the steam consumption was only 13·1lb. of water per indicated horse-power per hour, including the waste from the jackets, which was weighed against the engines. This consumption represents the mean of three equal periods of running at half, three-quarter, and full load respectively. The high efficiency is no doubt largely due to the excellent vacuum (28lb.) which was continuously maintained in the condenser. The small engine for driving the 15-kilowatt day-load alternator and the exciter is of the ordinary compound inverted high-speed type made by the firm; it runs at 300 revolutions per minute.

Alternators.—These are of Messrs. Ferranti's flywheel type, and are similar to those installed at Southport, Islington, and Portsmouth. The field-magnet system is built up on the rim of the flywheel, radial poles being inlet

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into the rim. The exciting coils consist of bare copper strip wound in a spiral, with insulation between adjacent turns. The armature is arranged outside the flywheel, and consists of a laminated core with windings sunk in the iron. A good mechanical construction is thus obtained, which is likely to give little trouble. The output of each of these alternators is 100 kilowatts. The voltage at the terminals is about 2,000, and the frequency is fixed at 50 complete cycles per second. This will allow of Continental makes of motors being used at reasonable speeds. Each large alternator is also provided with an exciter on the same shaft, but spare exciting gear is available as follows: The day-load engine is coupled direct to a small 15-kilowatt alternator on one side, and on the other to a direct-current 10-kilowatt dynamo. This latter machine will normally be used only as a day-load exciter, but its output is sufficient to excite both of the larger alternators at the same time. Arrangements are made at the switchboard for rapidly putting this dynamo on to the exciting circuit in case of need.

into the wall of the station, there being no back connections of any kind. The switch gear installed at present is sufficiently large to control four dynamos, two incandescent circuits, and two arc light circuits. Simplicity is a great feature of the switch gear, as the main supports have vertical sliding division pieces fixed into them, and the division between each upright slate is all the space required for the switch gear necessary to control either an alternator or a circuit, there being first the ammeter, underneath this comes the high-tension single-pole switch for breaking the 2,000-volt circuit, and underneath this switch on another slate shelf comes the oil fuse, and below this the exciter rheostat, ammeter, and field switch. Each panel bears a name plate describing what the particular switch controls, each switch thus forming its own diagram. The fuses in use are the Ferranti patent oil type. The great point about these fuses is that on the fuse blowing the contacts carrying same are immersed in heavy insulating oil, thus preventing the possibility of any arc being maintained. Fuse contacts are provided in duplicate, so that the working fuse can be removed

FIG. 6.—Ferranti Standard Switchboard.

Two rectifiers have also been supplied by Messrs. Ferranti and Co. These are each capable of feeding 30 arc lamps, and as only 14 arc lamps are at present in use they will have an easy time for a few months. We understand, however, that the Corporation are so pleased with the market lighting that additional lamps are now on order to be used in other streets. A new feature in these street lamps is that of having incandescent lamps on the same lamp-post for use after midnight. These are supplied from the low-tension mains, but are automatically switched on when the rectifiers are cut off at night. The usual switching gear for interchange of circuits and for reversing the polarity have been provided. A full account of a similar plant at Tunbridge Wells will be found on page 392 of our sixteenth volume.

SWITCH GEAR.

The switch gear at the South Shields electricity works installed by Messrs. Ferranti is constructed according to their standard methods. No wood or other inflammable material is used in its construction. The main supports which carry the switches, ammeters, etc., consist of black enamelled slate 2in. thick. These supports are built direct

for inspection or repairs by connecting a spare fuse to the duplicate contact-piece, by which means the breaking of the circuit is avoided. Similar fuses are used on both the dynamo and cable circuits. On the top of the board are mounted two electrostatic voltmeters, connected respectively to the high-tension and synchronising bars, and between the two voltmeters come the synchroniser and lamps. These switchboards are essentially designed for parallel working, and another great feature about the switch gear is the ease with which additional panels can be added.

With regard to the ammeters, these are of a special kind, and have been brought out by Messrs. Ferranti in order to meet a demand for an ammeter which could be read with ease and accuracy at a distance. As will be seen, the scale is vertical, and a large pointer is used to indicate the current. The divisions are wide compared with other ammeters now on the market. The very fact of the scales being vertical renders them much easier to read than ammeters with a semi-circular scale, quite apart from the fact of the wider divisions obtained between the indicating figures.

Messrs. Ferranti and Co. have devoted great attention

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to the design of their switching gear. Fig. 6 shows the Sheffield combination, which in detail resembles the one at South Shields, but is approximately twice as large. The individual panels for controlling feeders and machines are all uniform in design, occupying exactly 6in. horizontally. The compactness of the design is due in a great measure to the use of single-pole switches and fuses. The other poles of the alternators are permanently connected to the outside conductors of the concentric cables and are earthed. With large boards, as with the one illustrated above, the machines and feeders can be grouped into two sets at full load. This grouping minimises the effects of a sudden fault, and is preferable, when a large output is concerned, to running the whole of the machines on to one pair of 'bus bars. Thus in the switching gear erected by this firm for the City of London Company the load can be sub-divided into four main groups at full load, and again united into one group at light load.

(To be continued.)

SOME ELECTRICAL FEATURES OF THE UNITED STATES BATTLESHIP "INDIANA."*

Of the several heavy-armoured battleships of the United States Navy the "Indiana" is the most formidable, and in her design and equipment presents to the electrical as well as naval engineer the greatest interest. This ship was placed in commission on November 20, 1895. She is 348ft. long, 69ft. 3in. in breadth, has a draught of 24ft., and a displacement of 10,288 tons. She is provided with twin screws, each operated by triple-expansion engines, and which are capable of driving her at a speed of 16 knots per hour.

The main battery of breech-loading rifles consists of four 13in., carried in two turrets, one forward and the other aft, eight 8in. mounted within four turrets situated at the four quarters of the ship, and four 6in. Each discharge of the 13in. rifles produces a reacting pressure at the breach of 2¼ tons per square inch and a recoil of about 4ft. The secondary battery consists of 20 six-pounder and six one-pounder rapid-fire guns and four Gatlings. The thickness of the armour is 18in. and is of Harveyised nickel-steel. Thirty-six officers and 434 men constitute the crew, the commander being Robley D. Evans.

This magnificent specimen of naval architecture was built for the United States Navy, at a cost of £604,000, by the Wm. Cramp and Sons Ship and Engine Building Company, Philadelphia. Of greater interest to the reader is the electrical equipment which constitutes the basis for this article.

Mounting to the bridge on the mast, we find there installed two 24in. projectors or searchlights, one on the starboard, the other on the port side, each being furnished with an electrical control-stand, consisting of two small motors, one permitting of lateral training, the other of vertical. These motors are operated from a small platform above the bridge. The lights are rated at 20,000 c.p., and have horizontal carbons placed perpendicular to the Mangen or parabolic reflector, according to which is each is provided. The positive carbon, which is soft-cored and larger in diameter than the negative, has its crater towards the reflecting mirror. A small disc metal reflector perpendicular to and over the positive carbon also aids in reflecting scattered rays to the larger mirror. Two similar projectors are placed on the bridge deck aft and are operated from a platform under the bridge deck. Each projector is supplied with a Weston volt and ammeter, as well as a rheostat, which are located in the dynamo-room in a convenient position for the man in charge to handle. To the right of the bridge helm is an instrument called the helm indicator, forming a part of the Fiske system of ship telegraphs. It indicates the position of the helm at any instant, and is in principle merely a galvanometer, having its zero point in the central vertical position, and connected in parallel with a circuit such as shown in Fig. 1. Rigidly fastened to the rudder-post is a strip of resistance wire, through which a current from the main lighting circuit continually passes. As the rudder moves, a contact simultaneously slides over this resistance which cuts in or out more or less of it and therefore produces a corresponding change in the difference of potential at each indicator. These indicators are placed in various parts of the ship and are illuminated each by a small incandescent lamp.

Directly in front of the bridge helm is the compass, of the navy ordinance pattern, and to the left of this is the steering telegraph, the function of which is to telegraph to the steering wheels the position at which the officer in charge desires to have the helm placed. This transmitter, which is but one of several, is electrically

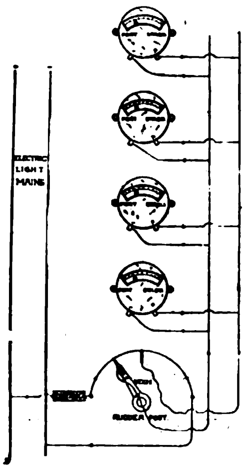

Fig. 1.—Connections for Helm Indicator.

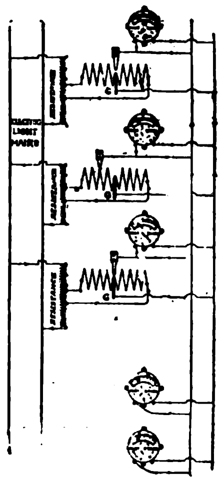

Fig. 2.—Connections for Steering Telegraph.

connected to indicators secured in conspicuous positions near the steering wheels and operated upon the same principle as the helm indicator just described. A diagram of the connections is shown in Fig. 2, where G represents the transmitters, which are located on the bridge, directly under the bridge in the pilot-house and directly under the pilot-house and within the mast, called the conning tower. In fact, the entire management of the ship

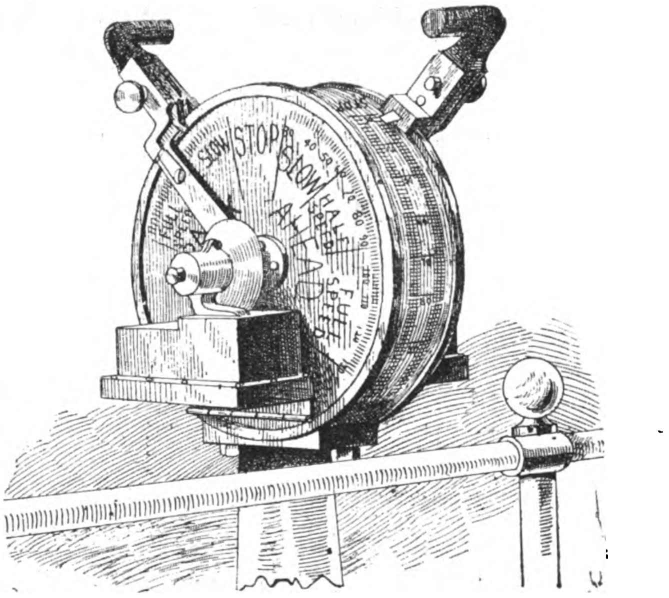

Fig. 3.—Engine Telegraph Transmitter.

can be controlled from either of these positions, the latter, which is heavily armoured, being used only in practice or an engagement. The movable contact of the transmitter, G, does not touch when in the central position, in which position it remains when not being used, so that any transmitter is independent of the others and may be used at any time.

After the command has been given to set the helm at a certain position indicated by all of the steering indicators, the precision with which the man at the helm obeys is

* From the *Electrical World* (New York).

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immediately recorded by a helm indicator placed near the former.

Fastened to the mast a few feet above the bridge is a speed and direction indicator having a port and starboard needle, which are respectively operated by the port and starboard engine shafts. This indicator is for the purpose of telling in which direction the shafts are running, and with the aid of a watch the number of revolutions may be determined. In principle the indicator is exceedingly simple, being merely a polarised relay. It is operated by a toothed eccentric strap fastened to the shaft and rolling, on which is a small tooth roller. As the shaft turns the

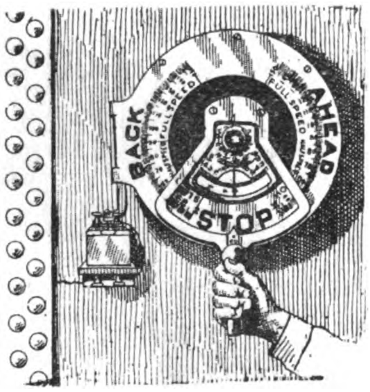

FIG. 4.—Engine Telegraph Receiver.

roller is shifted slightly, depending upon the direction of rotation, and at the same time raises at each turn a contact point which makes contact at either the right or left, thereby determining the direction of the current through the indicator at the bridge.

Another and far more important instrument to be found on the bridge is the Fiske engine telegraph. The function of this instrument is to signal to the engine-room the desired speed and direction of the engines. Each engine has its transmitter and receiver, the transmitters being in one instrument (Fig. 3) and one receiver (Fig. 6) in each engine-room. The telegraph is operated on the Wheatstone bridge principle, as shown in Figs. 5 and 6. Both the transmitter and receiver have equal resistances arranged in an arc of a circle. The zero position of each instrument is vertical. It

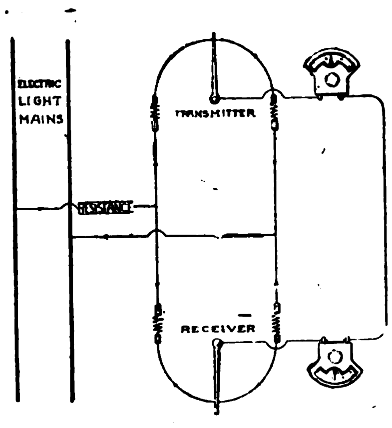

FIG. 5.—Sketch showing the Principle of the System of Telegraphs.

follows, therefore, that if the transmitter handle be moved over a given arc it will be necessary, in order to balance the bridge, to move the receiver handle a corresponding amount. In series with both the receiver and transmitter are galvanometers—that on the former being a Weston instrument. After the transmitter handle has been thrown over both galvanometers will deflect, and will continue to do so until balanced at the receiver. Thus the officer giving the command knows immediately if his order has been received. The Weston instrument, placed on the receiver, moves with the handle, and inasmuch as the needle is not balanced for all positions, it is necessary to have a second stationary galvanometer (shown at g^1, Fig. 6) to make more exact adjustments. This is done by shifting the handle and tapping the key A. Moving the arm of the transmitter over a very small arc automatically rings a 10in. gong located in the engine-room, thereby attracting the engineer's attention.

It will be seen in Fig. 3 that the engine telegraph has two handles. The two sides are duplicated, and transmit respective orders to the port and starboard engine-rooms. Placed at each side is a small 1-c.p. lamp to illuminate the faces at night. The whole system is operated by taking a drop across the lighting mains. The graduations on both the receiver and transmitter correspond to revolutions per minute.

There are two systems of night signalling used in conjunction with the electric lighting system. The truck light consists of a double lantern placed at the top of the mast, the upper half of the lantern being red, the lower white, in each half of which an incandescent lamp is placed. These lights are operated separately or together by means of a pulsating switch situated on the forward part of the mast on the top of the pilot-house. This signal is for the admiral's use in squadron evolution.

The second is called the Ardois signalling set, and is composed of four double lanterns, upper red, lower white,

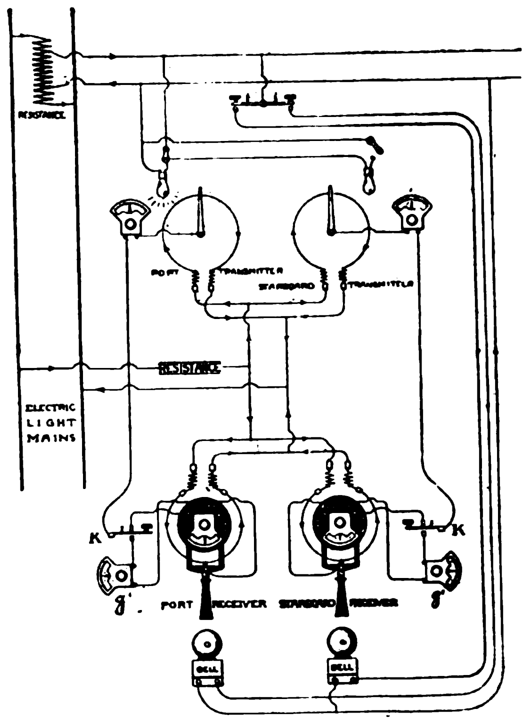

FIG. 6.—Diagrammatic Sketch of Engine Telegraph Connections.

having Fresnel lenses. These lanterns are suspended by two wire jack stays with connecting cross-arms, from the centre of which the lanterns hang, spaced 10ft. apart. The upper end of the jack stays is secured aloft to a stay, and the lower end sets up with two turn-buckles, one on each leg. There is a cable containing a wire for each lamp with a common return, which is connected electrically to a key-board (Fig. 7). The face of the board is divided into sections; each one of these sections is marked with the number and order in which the lanterns will burn when the key is moved to this section. These sections designate numerals, letters, or sentences. By this system it is possible to form 64 combinations. The type of lantern used is shown in Fig. 8.

Passing from the bridge to the pilot-house an addition to the instruments already described is one for automatically blowing the whistle at stated intervals. It is simply a clock arrangement operating an electric contact, completing a circuit which in turn operates by means of a magnet a lever attached to the steam whistle. A telephone also runs from the pilot-house to the "central station," where it is connected to the desired circuit.

The Fiske "range finder," one instrument of which is situated just above the bridge and the other on the bridge deck aft, 42⅝ yards apart, consists of two pedestals, on

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each of which is mounted a telescope with cross hairs, also an indicating instrument placed in the conning tower, consisting of a Deprez-d'Arsonval type galvanometer, manufactured by the Weston Instrument Company. The graduations on the galvanometer are in yards. The observers at the two telescopes are connected by telephone with each other, and with the observer at the indicating instrument. The operation of these instruments is also based on the Wheatstone bridge principle, but instead of employing resistances in the form of arcs of circles, the resistance wire is wound upon cylinders which, by means of proper gear, revolve simultaneously with the lateral movement of the telescopes. This method allows of correcting for inequalities in the resistance wires. When the two telescopes are parallel, and the circuits are in correct adjustment, the reading instrument, located in the conning tower, points at infinity. An adjustable resistance is in series with the voltmeter, so that if the E.M.F. of the storage battery supplying the circuit changes or the resistance of the indicator changes, due to temperature effects, the same may be corrected.

Upon pointing the two telescopes upon the same object the indicator needle is deflected and will indicate the distance in yards, and the object is from a position on the base line halfway between the two instruments. Space will not permit of showing how the indicator is graduated, it being done, however, by a simple trigonometrical process. Similar range indicators are located at the various guns,

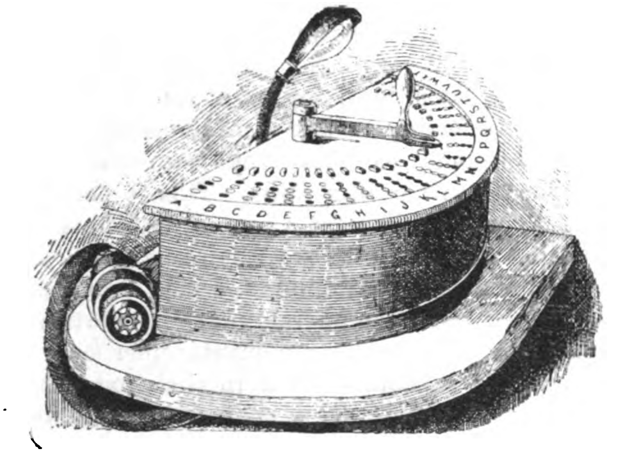

FIG. 7.—Keyboard of Signalling Set.

the entire firing of which is directed from the conning tower.

The 8in. gun turrets have electrically-operated hoists for lifting ammunition from the lower deck to the gun breech. These equipments were furnished by the General Electric Company. In the 13in. gun turrets two Lundell fan motors are used to blow the smoke out.

The dynamo and engine room contains three navy standard marine generating sets composed of three 24-kilowatt G. E. compound-wound dynamos, connected direct to three G. E. navy standard marine vertical double-cylinder engines. The units run at 400 revolutions per minute, and deliver each 300 amperes at 80 volts. The switchboard is designed for 22 circuits, 20 now being in use. There are two switches for the lighting circuits, four for searchlights and six for ammunition hoist motors. The switches are arranged so that each can be thrown on one of the three dynamos; the board is also provided with three parallel switches for throwing dynamos in parallel when necessary. There are two instrument boards, one on each side of the switchboard, the one on the left having two Weston station voltmeters, ground detector lamp, and switches; one voltmeter is used for the lighting and motor circuits, the other for the searchlights. The instrument board to the right has mounted upon its face three Weston astatic ammeters, one for each machine. The ship is supplied with the necessary electrical testing instruments, consisting of one 20,000-ohm magneto, one Evershed testing set, comprising one portable hand generator and ohmmeter. There is also supplied for testing one hand tachometer, one hand speed indicator, and three Tabor engine indicators. There are 615 incandescent lights installed on the ship with the necessary watertight feed and junction boxes, switches, and receptacles. Two running lights or lanterns are attached to the mast, the upper one being the mast headlight and the lower is used with the upper when towing. The side lights are composed of two stationary lanterns—one on the port and one on the starboard side of the vessel. These lights are burning only when the ship is motion. When the ship is at anchor there is a lantern hung on a halyard halfway from top of mast to bow, also a lantern at the stern, and a lantern swung out by means of a boom over each propeller. The lights are distributed throughout the ship by means of two sets of circuits—one being the lighting circuit, the other the battle circuit, which is only used when the ship is in action.

The fixtures are all of the navy standard pattern. They are all of a specially watertight type, and are composed of battle lanterns, hand portables, deck lanterns, desk lights, bulkhead fixtures, cargo reflectors, and electroliers. In the officers' quarters the fixtures are all silver-plated. The wire used for this work is of the navy standard, and was furnished by the Safety Insulated Wire and Cable Company, New York. Taking all the different sizes there is about seven miles of wire and about 3½ miles of wood

FIG. 8.—Ardois Lamp.

moulding for the same. The wires are all in moulding, and are very thoroughly insulated, being carried through rubber tubing at each beam, the beams being 4ft. apart, and through watertight stuffing-tubes at each watertight bulkhead, or where the wires pass through decks.

There is a complete set of fire and water alarms throughout the ship. The electric thermostats consist of an iron thimble containing mercury, and provided with a non-combustible fibre cork. Through the latter is a small screw passing down through a glass tube. By turning the screw the thermostat may be set for any desired temperature. Upon heat being applied to the thimble the mercury rises and makes contact, which indicates on an annunciator placed aft. The water alarm consists simply of a float, which rises and completes an electrical circuit when the water in that particular department attains a certain height.

A telephone system consisting of 24 Claymond telephones and a "central station" is one of the features. Speaking-tubes with buttons and annunciators are run from all principal points to the central station and conning tower. The central station is located in the forward part of the protective deck inside of the armour belt. Lieutenant Fiske's apparatus was made by the Western Electric Company, and with the exception of the range finder was installed, together with the annunciator, fire alarm, revolution counters, etc., by Messrs. Charles Cory and Son, New York.

From the foregoing description it will be seen that electricity now plays a most important *rôle* in modern naval engineering.

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MUNICIPAL APPOINTMENTS.

The general tendency in this country towards municipal ownership has already provided appointments for a large number of electrical engineers. There are also signs that electric traction will in many towns be kept in the hands of the authorities, and that for this department also a number of engineers will be required. Amongst the first municipal appointments in electric traction work to be filled is that of clerk of the works at Leeds. We notice elsewhere in our columns the fact that the committee has decided to appoint a man whose extensive experience in similar work elsewhere warrants the support he received. It is an appointment made on the merits of the case, coupled, however, with a consideration of the salaries asked by the various competitors. The only point on which we understand that some of the unsuccessful applicants feel aggrieved is that the salary should have had so large an influence on the committee's decision. The five engineers selected to appear before the committee all asked for different salaries, which varied by over 150 per cent. The candidates were given to understand that the gentleman who should be chosen to act as clerk of the works during construction would most likely be appointed engineer afterwards. This fact may have had a great influence on the candidates in fixing what salary to ask, some men preferring to ask a small salary for the first appointment, so that they may make sure of the good position afterwards. This is perfectly justifiable, but hardly what a committee wants. A corporation can afford to pay a fair salary for work done, and should, in our opinion, decide beforehand what is the fair remuneration for a particular appointment. Then the applicants differ only in their personal capabilities and in their experience of the work required. This course simplifies very much the process of selection, and tends toward an adequate remuneration being given to technical officers. It is much better for all concerned that such salaries should be fixed with regard to the capital expenditure involved, and not to the lowest figures at which the work can be done. When this is done, we shall not have the continual moving of prominent officials so much in evidence lately. Another feature of municipal appointments we have often referred to is that of the relationship between the engineer and his committee. In most towns, after the supply has been commenced, the engineer prepares plans for extensions and superintends this department of the work. All his proposals, however, are considered by his committee, and it is not an unknown occurrence for work to be considerably delayed in consequence. Still, it is the engineer's duty to keep the authorities in touch with all that concerns the welfare of his department, and above all in electricity work to keep up the regularity of the supply. Any small defect arising in the system should, of course, be promptly attended to, but the engineer must not allow the matter of large repairs or renewals to demand sudden attention without warning those to whom he is responsible. We believe that this consideration has prompted the Blackpool report, which we print in another

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column. The new engineer has seen what he considers to be grave defects in this system of mains, which, coupled with a depreciation of the insulation, may interrupt the supply. Other matters in connection with the economical supply in his opinion calls for alteration, and consequently some parts of the report will not be pleasant reading to those who have had to do with this station in the past. The engineer in question has laid himself open to the usual taunt of being "a new broom," but we are glad to hear that the report has been accepted by the Corporation, and that the defects will be speedily remedied. This support will encourage the engineer in the arduous task before him, and we trust that the necessary alteration will be made without prejudicing the supply. There is one feature in the report of which we do not approve, and that is of recommending that certain plant should be ordered from a given firm. All such orders for extension should be open to competition, and the competition should be as little influenced as possible by the preference of the engineer for a given type.

"PRACTICABLE" AND "PRACTICAL."

BY F. M. WEYMOUTH.

It is, perhaps, one of the most common mistakes of the day not to distinguish between what is practical and what is practicable. So many curious things, at any rate, have come under the writer's notice in this direction at various times, resulting more or less from a confusion of these terms, that he is led to believe some remarks on the subject may not be amiss. It is a clear conception of the difference between these terms which is apparently so often wanting in many minds.

We may perhaps, then, best commence, rather than by enunciating any particular definitions, by illustrating the problem with some general example. Suppose, for instance, anyone desired to travel, say, from Westminster to the City. A host of methods of travel may all be practicable. He may go by a balloon, or be hoisted by kites, or even with ladders clamber over the housetops. But more practical ways are to take a train, cab, or 'bus, or to walk. We thus see that while many ways of doing a thing may be practicable, all are not practical A certain point, indeed, is at once foreshadowed—namely, that unpractical ways are frequently absurd, though yet practicable, the pity being that the absurdity of some enterprises as wanting in sensibleness as any of the above is not perceived by those responsible. But, keeping to our illustration, we may note that the term practical is a comprehensive one, and includes within its meaning various specific qualities. Thus, besides sensibleness, or what is popularly known as "common sense," time and cost may be considered. The cheapest way, obviously, if time is less an object, is to walk, while a 'bus will give the cheapest ride. If time is more an object, then it is a matter of experience or computation whether a cab or the train will be the quicker; in short, it may be said that the term practical applies when in the accomplishment of any object such as the above, before it is attempted, all points of consideration are duly thought about beforehand, so that the particular method of procedure finally decided on shall be the most reasonable and the best. This may then be termed the "practical" method, as compared with any others, which, howsoever absurd, may yet be "practicable."

But to come from generalities to what is more technical, we may observe that in electrical and engineering work it is in matters of construction that perhaps most frequently we want to know what is practical. Here again, then, to quote an example by way of better illustrating our argument, we may draw attention to the difference between the locomotive on the road and that on the rail. The former, usually known as a traction engine, has toothed gearing, while the latter has not. Yet it would be quite practicable to reverse the order and put a geared locomotive on the railway and one direct acting without gear on the road. But "practical considerations" do not commend such reversal. The railway is perfectly smooth, has no sharp turns, and is laid with comparatively slight gradients. The road, on the other hand, is liable to be rough and undulating, has sharp turns round street corners, and so forth, and has steep gradients. Moreover, a high speed is required on the rails and a slow speed on the road. It is, thus, for all these "practical considerations" that we find these classes of locomotive so different in design. On the road, in order to overcome the momentary and intermittent resistances due to its roughness, and to maintain evenness of speed, a quickly revolving flywheel is necessary, that by means of its stored-up energy such resistances may be at once overcome and an even speed maintained. Two or more changes of speed in the gear will also enable great variations of gradient to be easily dealt with. These difficulties not being present in the case of an ordinary railway, flywheels and gear are not needed, and though gear was used in early days, if added in these modern times without special reason, it would merely constitute an unnecessary and unwarranted complication.

Let us look, however, at some electrical work. Switches, for instance, deserve some attention, also the brush gear of dynamos and motors. How many switches have we not seen which after a little use have become loose and "ramshackle." Their construction has been quite practicable, plainly, but their "practicality" is quite another thing. That kind of switch, for instance, whereof the rotating part is a stalk, whose lower end is fitted into a single socket in the base, and the moving contact-making arm protrudes from, or passes through, the stalk just above the socket, while an obliquely-disposed handle is led off from the top. Such a switch, say about 6in. in diameter, is put to control a motor. What is the result? A workman's heavy hand is continually on the outer end of this handle, and every time the switch is used the lower end of the stalk is ground round in its socket with this great one-sided leverage. The result is that the socket is soon worn larger than the stalk, so that the latter can then "wobble," being no longer properly held. Taper sockets have been used, but fit is apt soon to go. Yet a design of switch which takes all this heavy-handed manipulation into account is not at all impossible. Thus a switch designed for strength, and made perhaps a little larger than absolutely required for the current, and, what is more to the point, made with bearings at both ends of the stalk instead of the single socket, would endure far more wear and be proportionately more "practical."

We may now touch on a curious point in connection with brush gears. It would seem that the early electrician, after the flying to pieces of some armatures owing to neglecting centrifugal force, and so forth, was glad of the aid of the mechanical engineer in constructing dynamos and motors, but always reserved one thing—the brush gear. But in this reservation, as we shall show, the early electrician made a mistake; for he introduced a very unpractical thing in his design which has remained ever since. We allude to the method of applying the tightening springs for keeping the brushes up to their work; for in most cases we find these springs arranged so that they act tangentially with the commutator at the point of contact, the consequence being that as the brushes wear they are pulled away from their proper position. The slope of the brushes and the angle of the contact ends are both altered. It is thus rendered necessary to entirely reset the brushes many times before they are used up. We hence find here another instance in which a design has not been so "practical" as it might have been. A more practical design, inasmuch as such effects are easily to be foreseen, would avoid this trouble in usage, and so would have it arranged that while the brushes were kept up to their work, and fed up as they wore, yet the means for so doing should not draw them away from their proper position, nor alter their angle with the horizontal. This little point has apparently, however, been receiving some attention, and we note that the Admiralty have been demanding brushes with forward thrust.

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We have thus to observe that in matters of construction the term "practical" includes the condition that all parts must be designed and put together with a due regard to the stresses and strains in each part. It will, however, also include the use of proper materials. Metal or other material must be properly "placed," and not a great mass put where there will be scarcely any strain, and only a little material where the strain will be great—cases of ineptitude in design by no means unknown. An instance may be cited of an armature spider cast with enormously thick radial ribs, involving great waste of gunmetal, and yet with an end plate cast on one end so thin that it deflected when the core discs were tightened against it by a nut at the other end.

A few examples only have been given above. Many more might be added. We may merely conclude by remarking that it would probably be a surprise to many were it better known, especially when these errors occur on a large scale, how many disappointments and failures of enterprise have resulted simply from a want of a proper appreciation of the very wide difference between "practicable" and "practical."

THE PRINCIPLES OF ALTERNATE-CURRENT WORKING.*

BY ALFRED HAY, B.SC.(EDIN.), A.I.E.E.

(Continued from page 234.)

50. Since an alternating P.D. or current varies from instant to instant, it is at once evident that if we are

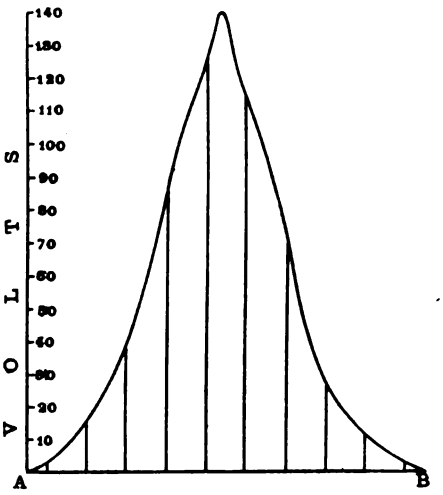

Fig. 44.

to measure such a varying quantity, it becomes necessary to define exactly what we mean when speaking of *one volt of alternating P.D.*, or *one ampere of alternating current.* Since the waves of P.D. and current which we are considering are supposed to be symmetrical with regard to positive and negative half-waves, it follows at once that the mean *algebraical* value of the P.D. or current over any complete number of periods is nothing. We are not, however, concerned with the mean algebraical value, for this gives us absolutely no clue as to the magnitude of the current. In some cases it is important to consider the mean *numerical* value of the current over a complete period, or, which comes to the same thing, its mean value over a positive or a negative half-period. In order to determine this value, we may adopt the method used by engineers in working out the mean pressure from an indicator diagram. Thus, let the curve in Fig. 44 represent a positive half-wave of P.D. In order to determine the *mean value* of the P.D., divide the half-period A B into a convenient number of equal parts,† and at the middle point of each division draw a perpendicular to the axis of time. By taking the sum of the lengths of these perpendiculars and dividing by their number, we obtain the mean value of the P.D. In the example under consideration (Fig. 44) we find that the lengths of the perpendiculars are

3, 15, 39·6, 86·4, 126, 115·5, 69·6, 27, 11·4, and 3

respectively. Hence the mean value is

$$\frac{3+15+39{\cdot}6+86{\cdot}4+126+115{\cdot}5+69{\cdot}6+27+11{\cdot}4+3}{10}$$
$$= 49{\cdot}65 \text{ volts.}$$

A knowledge of the mean value of a given E.M.F. wave is of importance in the design of alternators, for it is this value which is calculated most readily. As a typical example, let us suppose that an alternator field magnet consists of a frame furnished with polar projections, as shown in Fig. 45, the projections being of north-seeking and south-seeking polarity alternately. Let C C′ be one of the alternator armature coils, of S turns, and let us suppose that in t seconds this coil is carried from its initial position (opposite a north-seeking pole) to the position shown dotted (opposite the neighbouring south-seeking pole). If N stand for the total number of C.G.S. lines which proceed from each pole, the change in the number of lines through each turn of the coil is from + N to - N—*i.e.*, the total change amounts to 2 N. Since the change has taken place in t seconds, the E.M.F., in C.G.S. units, induced in each turn of the coil amounts to $\frac{2\,N}{t}$. Hence the total E.M.F., in volts, induced in the whole coil is

$$\frac{2\,N\,S}{t} \times 10^{-8} \text{ volts.}$$

If there are n coils connected in series in the armature winding, then the total *mean* E.M.F. of the alternator is the above expression multiplied by n. It is thus quite easy to calculate the *mean* E.M.F. developed by a given alternator when the magnetic flux from each pole and the speed are given.

51. In other cases, again, the quantity which it is important to know is the *maximum* value of the E.M.F. In the case of power transmission by means of high-potential alternating currents, the insulation of the line, transformers, etc., must be sufficiently good to withstand the greatest stress to which it may be subjected. But the latter depends solely on the *maximum* value of the E.M.F.

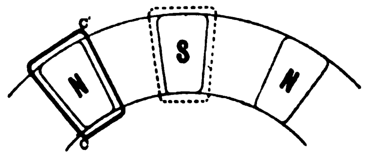

Fig. 45.

employed, so that in this case we are concerned with the *maximum* value, and not the mean value. From this point of view it is evident that, *apart from other considerations*, a *flat-topped* E.M.F. curve is to be preferred to a *peaked* one; for the latter puts a greater strain on the insulation than the former.

52. In most cases, however, it is neither the *mean*, nor yet the *maximum* value of the varying quantity which concerns us most. We now proceed to explain the nature of the quantity which is generally considered in all alternate-current measurement. Take the case of an incandescent lamp supplied with an alternating current. The amount of light given out by the lamp will obviously depend on the *heating effect* of the current. Now as the current varies, its heating effect will also vary from instant to instant. At any moment, however, *the heating effect will be proportional to the square of the corresponding value of the current.* Let in Fig. 46 the full-line curve A D B represent the curve of current. The dotted curve A E B is such that its ordinates are equal to the squares of the corresponding ordinates of A D B. Thus, the corresponding points D and E are so related that $CE = CD^2$. It follows from this that if A D B represent the variations of the current, A E B will represent the variations in the heating effect produced by the current. In order to determine the *mean heating effect*, on which the total amount of light given out by the lamp depends, we

* Based on a series of evening lectures delivered at the University College, Liverpool.

† The greater the number of divisions, the greater will be the accuracy obtained.

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must find the mean ordinate of the curve A E B. This is readily done by the method explained above (Art. 50). The mean ordinate of the curve A E B gives us the *mean value of th? square* of the current, or, briefly, the *mean square* of the current.

Let us next suppose that the same lamp is supplied with a continuous current which produces *the same heating effect* as the alternating current. In order that this may be the case, it is obvious that the square of the continuous current must equal the mean square of the alternating current. So that for equal heating effects we must have the relation

(continuous current)^2 = mean square of alternating current,

i.e, continuous current = $\sqrt{\text{mean square of alternating current}}$.

The inductance of an incandescent lamp is so small that it may be neglected, so that the impedance is practically equal to the resistance of the lamp. From this it follows that the current at any instant is simply equal to the quotient of the P.D. by the resistance. Hence the current wave will have precisely the same shape as, and be in phase with, the P.D. wave, and it follows that if instead of considering currents we consider P.D.'s, then for equal heating effects we must have

continuous P.D. = $\sqrt{\text{mean square of alternating P.D.}}$

Whether, therefore, we consider current or P.D., the important quantity from the point of view of the heating and lighting effects is *the square root of the mean square value.* For the sake of brevity, this latter quantity is generally referred to as the R.M.S. ("root mean square") value.

53. When we speak of so many volts of an alternating P.D., or so many amperes of an alternating current, we

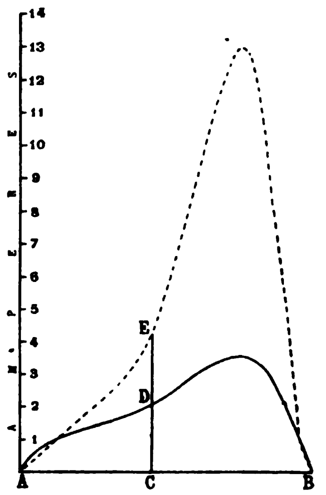

FIG. 46.

thereby mean their R.M.S. values. We thus have the following definitions:

An alternating P.D. of one volt [alternating current of one ampere] *is a P.D.* [current] *whose R.M.S. value is unity.*

A unit alternating current might otherwise be defined thus:

An alternating current of one ampere is an alternating current which, in a given conductor maintained at a constant temperature, produces heat at the same rate as that at which it would be produced in the same conductor under the same conditions by a continuous current of one ampere.

The student must be careful to discriminate between the R.M.S. and the *mean* values. Referring to Fig. 46, we find that the mean value of the current is 2·06 (which is the mean value of the ordinate of the curve A D B). The value of the mean square of the current (which is given by the mean ordinate of the dotted curve A E B) is 5·22, so that the R.M.S. value of the current is 2·28.

A knowledge of the relation between the R.M.S. and the mean values of a wave is of very considerable importance in some cases. Thus, let us suppose that we have to design an alternator of a certain type to give 100 volts at a given speed. By the 100 volts is meant the R.M.S. value of the E.M.F. Now the quantity which is directly calculable from the known dimensions and speed of the alternator is *not* the R.M.S. value, but (Art. 50) the mean value. It is thus necessary to know the relation between these two quantities for the given type of alternator before the calculation can be carried out. Dr. Fleming has proposed to give the name "form factor" to the ratio of the R.M.S. value to the mean value. The *form factor* varies in different types of machines from about 1·1 to about 1·4. If the form of the E.M.F. wave is known, then we can at once determine the *form factor.* Thus, we have found that the mean value of the ordinate of the E.M.F. curve, shown in Fig. 44, is (Art. 50) 49·65. In order to find the R.M.S. value, we first of all determine the mean square. This is done by squaring the lengths of the 10 ordinates, which gives us the numbers

9; 225; 1,568; 7,465; 15,876; 13,340; 4,844; 729; 130; and 9,

so that the mean square is 4,419·5, and hence the R.M.S. value is $\sqrt{4{,}419} = 66{\cdot}5$ volts. The *form factor* for this type of wave is therefore $\frac{66{\cdot}5}{49{\cdot}65} = 1{\cdot}34$.

54. We have next to consider the *measuring instruments* which may be used on alternate-current circuits.

An alternating P.D. may be measured by means of a Cardew or an electrostatic voltmeter. The readings of both these types of instruments are determined by the R.M.S. value of the P.D. In the case of the Cardew voltmeter, the reading of the instrument is determined by the heating effect produced by the current. Owing to the extremely small inductance (Art. 31) of the instrument, the current is in phase with the P.D., and is at any instant equal to the quotient of the P.D. by the resistance of the instrument. From this it follows that an alternating P.D. whose R.M.S. value is E volts will produce a current through the instrument whose R.M.S. value is equal to the continuous current produced by a continuous P.D. of E volts. But (Art. 52) an alternating current whose R.M.S. value is equal to a certain continuous current produces the same heating effect as this continuous current in a conductor of given resistance. Hence an alternating P.D. whose R.M.S. value is E volts will give the same deflection as a continuous P.D. of E volts, so that *a Cardew voltmeter which has been calibrated with continuous P.D.'s will read correctly when placed on an alternate-current circuit, and the quantity which it measures is the R.M.S. value of the P.D.*

Considering next the case of an electrostatic voltmeter, it will be readily seen that since for a given position of the moving part of the instrument the couple acting on it is proportional to the *square* of the P.D., the deflection produced by an alternating P.D. whose R.M.S. value is E volts will be the same as that produced by a continuous P.D. of E volts; for the mean couple in the first case is the same as the steady couple in the second. Hence an electrostatic voltmeter calibrated with continuous P.D.'s will correctly read alternating P.D.'s.

Electrodynamic and electromagnetic voltmeters are not very suitable for alternate-current circuits, and hence they are not much used on such circuits. Owing to the inductance of the coil of such an instrument, the current which passes through it is only a small fraction of that which would be obtained with a continuous P.D. of the same amount,* so that voltmeters of this kind have to be calibrated by using known *alternating* P.D.'s. Further, since the current passing through the voltmeter depends on the impedance of the coil, and therefore on the periodicity, an instrument calibrated on a circuit of given periodicity will not be correct for another circuit whose periodicity is different. To give the student some idea of the effect produced by the inductance of the voltmeter coil, it may be mentioned that in the case of a voltmeter of the Ayrton and Perry magnifying spring type, a P.D, which, if steady, gives the maximum scale reading, will, if alternating with a periodicity of 100 ∿ per second, produce a deflection which is not even readable on the scale.

The most satisfactory instruments, from every point of view, for measuring alternating P.D's are those of the

* Unless a large non-inductive resistance be connected in series with the voltmeter coil, so as to make the impedance practically equal to the resistance; in that case, however, the current is also greatly reduced, and the controlling couple must be diminished.

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electrostatic type, and these will probably altogether displace instruments of other types.

55. An alternating *current* may be measured by a Siemens electrodynamometer, a Kelvin balance, or an electromagnetic ammeter. The first two instruments named will read the R.M.S. value of the current correctly on an alternate-current circuit if previously calibrated with continuous currents. But an *electromagnetic ammeter* which has been calibrated with continuous currents will *not* read correctly on an alternate-current circuit, and must be specially calibrated with alternating currents of the same periodicity as that of the circuit on which the instrument is to be used.

(To be continued.)

RAILWAY BLOCK SIGNALLING.

BY J. PIGG.

(Continued from page 232.)

The special apparatus for ensuring safety of working already described has been of a partial character only, and adapted to meet given circumstances. Figs. 55-66 illustrate Saxby and Farmer's union of the locking apparatus of the mechanical signals with the block signalling apparatus, and constitutes a more complete attempt to meet all the contingencies which can be foreseen. The objects aimed at in the design, besides the ordinary block signalling, are (*a*) the locking of the instrument handle at the receiving end of the section, until the train signalled has passed a pre-arranged point at that place; (*b*) the locking of all points and signal levers, the operation of which involves fouling of the running line, for all positions of the block instrument handles, except the normal position, when the section is unoccupied; (*c*) the locking of the "starting" or "advance" signal to danger for all positions of the block indicators except "Line clear;" (*d*) ensuring the raising of the signal to danger when it is no longer required to be "off" for the train signalled, and accepted, to proceed. The block indicator and signalling apparatus follows the usual line of design for single-wire instruments, and consists of a ringing and signalling plunger, a commutator for reversing the direction of the currents sent, the electromagnets for working the semaphore indicators, a relay, and a bell. All signals are given by the plunger, and the direction of the currents so sent is controlled by the position of the handle of the instrument. Currents pass through the electromagnets actuating the lower semaphore indicator at the home station, and through the upper electromagnets at the distant station. The non-polarised relay is actuated by all currents, and the bell is rung accordingly. In connection with the upper semaphore arm is a mercury contact switch, which makes or breaks a circuit passing to the starting signal according as the semaphore arm is down or up. A similar switch is worked in connection with the mechanism provided for locking the handle of the block instrument. This switch completes a circuit through the handle-releasing coils and a rail treadle which brings them into action, when the handle is on the "Train on line" position, and breaks the circuit when the handle occupies either the "Line clear" or "normal" (line blocked) positions. Besides these two switches there is an electromagnetic two-way mercury contact switch, in a separate case, which is used in connection with the working of the starting signal.

Fig. 55 is a side view of the instrument with the case removed, and shows the general arrangement of the indicator electromagnets, A, the handle-releasing coils, B, the ringing and signalling plunger, P, the commutator, H, and the switch, S, in connection with the upper semaphore arm. Fig. 56 shows the mechanism for locking the commutator handle in the "Train on line" position after it has occupied the "Line clear" position, and also shows the mercury switch, S_1, in connection with the releasing circuit. Figs. 58, 59, and 60 show the various positions of the handle-locking mechanism for the "normal," "Line clear," and "Train on line" positions respectively. The curved lever, L, is raised when the handle is placed to "Line clear," and a small stud, shown in dotted lines in Fig. 58, engages with the projection of the armature of the releasing coils, B (Figs. 55 and 56), and is held there until the armature is attracted, which takes place when the train passes over the rail treadle provided for closing the circuit. The same movement causes the shaded disc, F (Fig. 58), to appear at the opening, N (Fig. 57), in the front of the instrument.

Fig. 57 shows the arrangement of the commutator. As shown, with the handle in the "Line blocked," or normal position, the depression of the plunger puts the springs, *a* and *b* in contact, and also springs *c* and *d*, and at the same time breaks contact between *c* and *e*. The current so sent does not affect the indicators at either station, and the only effect is to ring the bell. When the handle of the

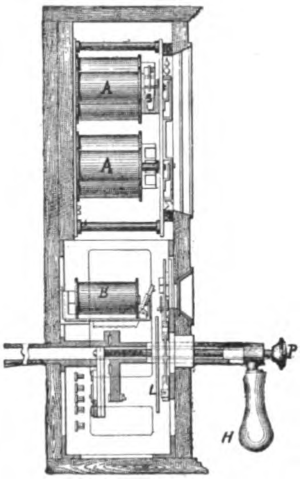

Fig. 55.

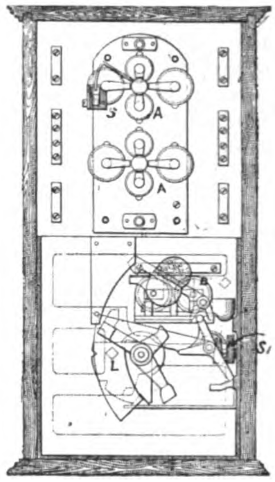

Fig. 56.

commutator is placed to "Line clear," depression of the plunger connects springs *a* and *d* and *b* and *c*, and breaks contact between *c* and *e* as before. The direction of the current is now reversed, and the lower semaphore arm at the home station and the upper semaphore arm at the distant station are lowered, and indicate "Line clear." When the handle is in the midway, or "Train on line," position, depression of the plunger effects the same combination as when in the normal position, and the currents so sent raise the lower arm at the home station and the upper arm at the distant station to horizontal positions. Fig. 61 shows a plan and

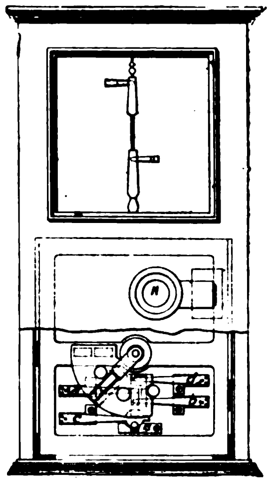

Fig. 57.

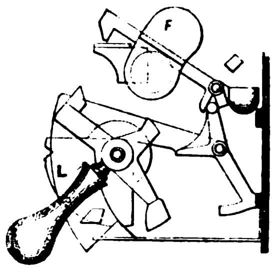

Fig. 58.

front elevation of the special mercury switch used in connection with the electrical control of the starting signal, and Fig. 61A shows a side elevation of the same. Fig. 62 shows the method of locking the levers of fouling points, etc., with the handle of the block instrument in the "Line clear" and "Train on line" positions. Conversely, the handle of the block instrument is locked in the "Line blocked," or normal position, when these levers are being operated.

Figs. 63, 64, 65 show the operation of the electrical control of the starting signal, and Fig. 66 is a diagram of the connections for one complete block circuit. The form

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of rail treadle used in connection with the system is shown by Figs. 39 and 40.

The operation of the instruments for signalling is very similar to that of some of the instruments already described, and need only be referred to very briefly. The "Is line clear," or equivalent signal, is given from the sending end with the handle in the "Line blocked" position. If the signalman at the receiving end is in a position to accept this signal, he first moves the handle of his instrument to the "Line clear" position, and gives the appropriate accepting signal. The semaphore arms are lowered at both stations, as already described, by the accepting signal, and remain in this position, indicating "Line clear," until further signals are exchanged. It will noted that owing to the locking of the handle of the instrument by the mechanism shown in Fig. 56, the ability to place the handle to "Line clear" is proof that the previous train has passed over the handle-releasing treadle, and owing to the interlocking of the block instrument handle with the levers controlling fouling points, the ability to move the handle from the "Line blocked" position is proof that the line is clear of

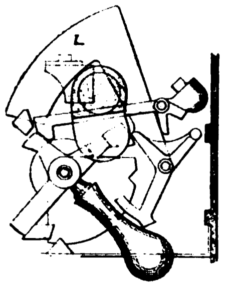

Fig. 59.

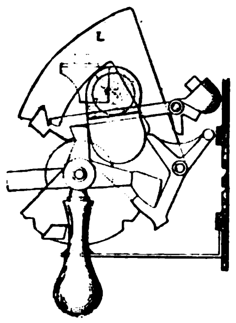

Fig. 60.

shunting or similar operations. Further, the act of placing the handle to "Line clear" raises the curved lever, L, until it engages with the armature of the releasing coils. Once in this position the locking mechanism prevents it being replaced in the "Line blocked" position until after the armature of the releasing coils has been moved. This, of course, under normal conditions, is done by the passage of the train over the treadle, but it should also be noted that the passage of a train over the treadle during the time the handle is to "Line clear" will not actuate the armature of the releasing coils, owing to the switch, S_1, being open in that position. S_1 is only closed when the handle is in the

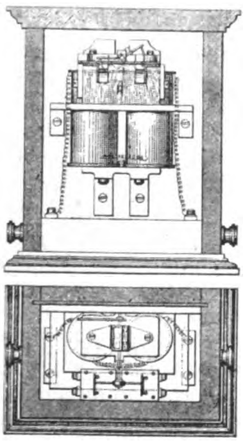

Fig. 61.—Electromagnetic Mercury Contact Switch for Controlling Outdoor Signal.

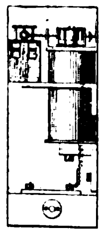

Fig. 61a.

"Train on line" position. The lowering of the upper semaphore arm at the sending end causes a local current to be established which passes from the battery, D, through the switches, S and S_2, to the controlling electromagnet on the starting signal.

Under normal conditions—*i.e.*, when the signal arm and the lever working it are both in the "on" position—the armature of the electromagnet on the signal is kept up to the poles, as shown in Fig. 63, and the continuity of the circuit is maintained in this position only. When the signal lever is put in the "off" position, this mechanical support is withdrawn, and if there is no current passing through the coils of the electromagnet the armature will fall, and the apparatus will occupy the position shown by Fig. 65. If, however, the local current through S, S_2, D has been previously established, the armature is held by the electromagnet, and the action of the balance weight on the levers and links allows the arm to assume

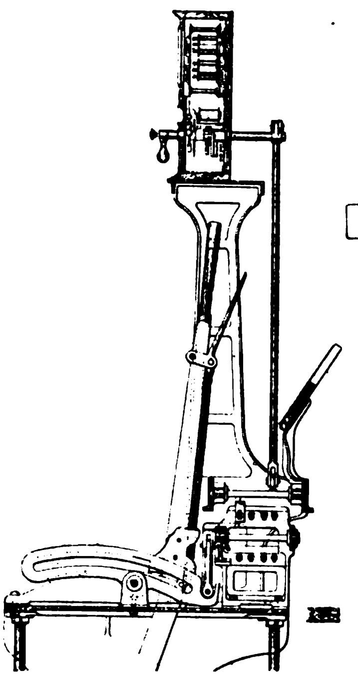

Fig. 62. – Interlocking of Bl ck Instruments with Point Fouling Running Line.

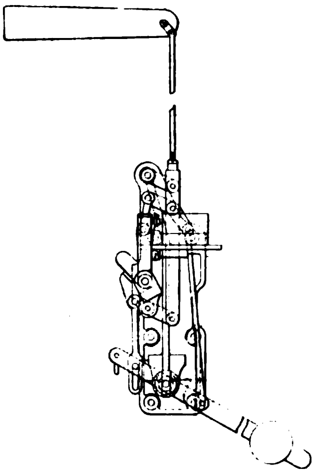

Fig. 63.

the "off" position as in Fig. 64. If a break occurs anywhere in the local circuit during the time the signal lever is "off," and the balance weight occupies the position shown in Fig. 64, the armature is freed, and, being unsupported mechanically, falls into the position shown in Fig. 65; the relative weights of the signal arm and the central lever carrying the rod being sufficient to effect this movement. An examination of the local circuit shows that it may be broken at three points—viz., at S, S_2, and at the signal. If the upper semaphore arm is raised, the switch S will break the local circuit. This action must take place when the signalman at the receiving end

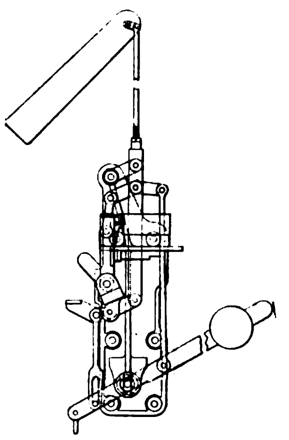

Fig. 64.

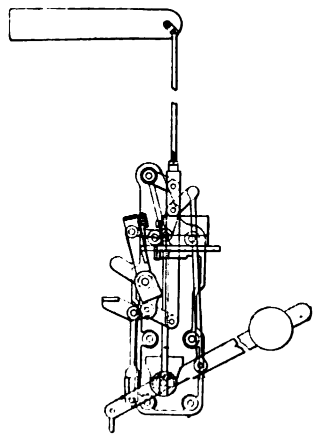

Fig. 65.

acknowledges the "Train on line" signal, and it therefore follows that the signal arm cannot remain at "off" after the "Train on line" signal has been acknowledged, although the lever working the arm has been left in the "off" position. Hence we see that the signalman at the sending end is not only dependent upon the signalman at the receiving end for the release of the starting signal, but the latter will replace it if the former neglects to do so. It is, however, by no means impossible for the signalman at the sending end to obtain the "Line clear" indication for a train and, from forgetfulness, neglect to forward the "Train on line" signal. Under such circumstances the signal

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would remain at "off," if no other device than those described was in operation. A further examination of Fig. 66 will show that the electromagnet of S_2 is in connection with a second rail treadle, through the same battery as is used for the circuit S, S_2, and signal electromagnet. If this circuit is closed, the switch S_2 is reversed, and, breaking the circuit through the signal electromagnet, allows the arm to assume the "on" position. Although the closing of this circuit may be only momentary, it will be seen from Fig. 66 that the reversal of S_2 has the effect of diverting the current, previously passing through the signal electromagnet, through the electromagnet of S_2, and so maintains the reversed position of the latter until the indicating semaphore arm is raised, when, the switch S being open, the circuits from the battery, D, are broken, and S_2 resumes the position shown in the diagram of connections, and is ready for another train.

From the description it will be evident that the signalman at the receiving end is master of the situation. The signalman at the sending end cannot lower the signal for a train to proceed until he has received "Line clear" from the station ahead; and if he does not himself replace this signal at the proper time it is done by the acknowledgment of the "Train on line" signal from the receiving end; or, in the event of the train being sent forward without this signal being given and acknowledged, it is done by the action of the train passing over the treadle, and the signalman is unable to again lower it until the indicating semaphore has been raised and lowered again. When the "Train on line" signal is received from the sending end of the section, the signalman at the receiving end places the handle of his instrument in the midway position, which is the only movement possible, and acknowledges the signal in accordance with the code. The movement of the handle locks it in the midway position, and it cannot now be moved in either direction. The switch S_1 is closed by the same action. On the arrival of the train at the receiving end of the section, it passes over the treadle in connection with the battery, G, and a current is established through the switch S_1 and the handle-releasing coils. The armature is attracted, and allows L to drop into the position shown in Fig. 58. The handle of the instrument is now free, and may be placed in either the "Line blocked" or the "Line clear" positions. The proper position for it is, of course, the "Line blocked" position, and when this is done the "arrival" signal is given according to code.

This system is an interesting example of the possibilities of block working, and also of the difficulties to be overcome before even a moderate check can be established over those engaged on working traffic. The elaborate precautions taken to ensure the replacement of the starting signal after it has fulfilled its duty, and to ensure its not being used to send a train forward prematurely, mark the starting signal as being of the utmost importance in the estimation of the designer. There can be no doubt that the position of this signal is of great importance, but the history of railway accidents shows that its being in the "on" position has not always acted to prevent a train from passing into the section it protects, with disastrous results in some cases. The apparatus in connection with the starting signal has, obviously, been designed solely with the object of checking the action of the signalman, and provides in no way against the possibility of error on the part of that other important factor in the problem, the engine driver. Further consideration of the arrangements for unlocking the starting signal suggests the possibility of this being done through accidental contact between the line wire and another working wire along the route between the two ends of the section.

The next important point in the system is the locking of the instrument handle, at the receiving end, until the train has passed over the treadles in connection with the releasing coils. It will be noticed (Fig. 59) that the operation of locking commences when the instrument has been prepared to give the "Line is clear" signal, and is completed when the "Train on line" signal is acknowledged. Once the handle has been moved to the "Line clear" position it cannot, in the course of ordinary working, be replaced to "Line blocked" before the treadle is operated. An "Is line clear" signal or "Train on line" signal cannot therefore be cancelled, in the sense that all the apparatus concerned may be returned to the "Line blocked" condition without special arrangements being made for releasing the handle at the receiving end of the section. Theoretically, the "Train on line" signal should never require cancelling, but there are occasions when it may be necessary Cancelling of the "Line clear" signal is of much more frequent occurrence, more especially in connection with junction working and at points where traffic is lifted and left. In the case of a junction, such as is shown in Fig. 11, the signalman there might offer the "Is line clear" signal, and have it accepted, from two or even the three advance cabins, in which case the three starting signals would all be unlocked electrically, and any one of them might be used. Such a case as is here supposed is by no means far-fetched. Where signalmen at junctions have to deal with a heavy mixed traffic they often have to rely upon the whistles given by the driver, and when the wind is in a contrary direction it is by no means easy to distinguish the number and length of the whistles given; and since the "Line clear" signal must be obtained before the arrival of the train at the cabin at the sending end in order to prevent delay, the cancelling signal becomes of some importance. Further examination of the handle-locking mechanism shows that it is not impossible for the signalman at the receiving end to (*a*) replace the indicating semaphore arms to "Line blocked" in the interval between his giving the "Line is clear" signal and receiving the "Train on line" signal; (*b*) give the "arrival" signal to the sending end at any time after receiving and acknowledging the "Train on line" signal, but the locking of his instrument handle would prevent him from accepting a second "Is line clear" signal. The apparatus provides indications representing "Line clear," "Train on line," and "Line blocked" at the receiv-

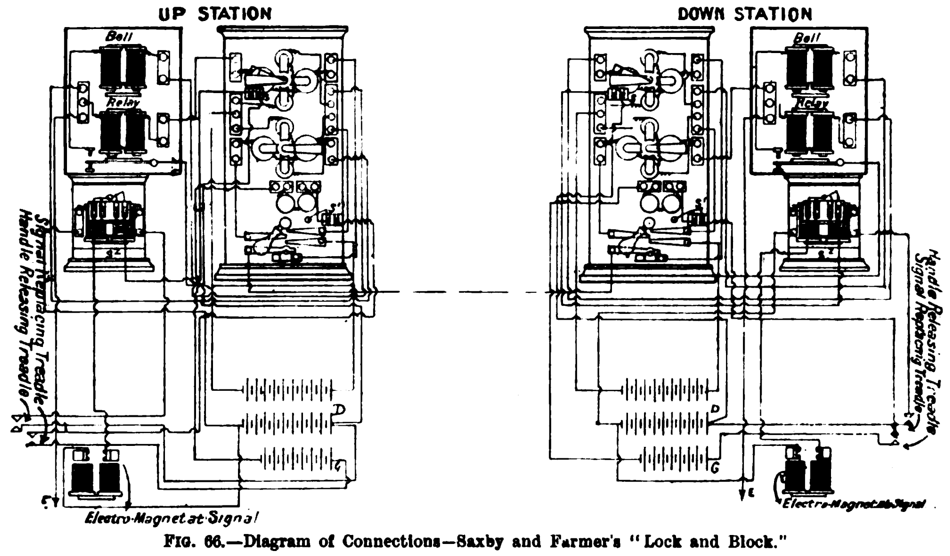

FIG. 66.—Diagram of Connections—Saxby and Farmer's "Lock and Block."

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ing end of the section, but does not distinguish between "Line blocked" and "Train on line" at the sending end.

(To be continued.)

THE POSTMASTER-GENERAL'S REPORT.

The following extracts from the report of the Duke of Norfolk supplements in many ways the brief note we were able to give last week:

It is estimated that during the year ending March 31, 1896, the following postal packets were delivered in the United Kingdom:

	Number estimated.	Increase or decrease per cent.	Average number to each person.
Letters	1,834,200,000	Inc. 3·6	46·8
Postcards	314,500,000	Inc. 0·6	8·0
Book packets, circulars, and samples	672,300,000	Inc. 9·4	17·1
Newspapers	149,000,000	Dec. 1·8	3·8
Parcels	60,527,000	Inc. 5 9	1·5
Total	3,030,527,000	Inc. 4 2	77·2

Except in the case of newspapers, the figures show an increase upon those of last year and tend to justify the view of my predecessor that the apparent decrease in the number of letters in 1894 was not to be taken as denoting any real cessation in the growth of postal business. Looking back over a long period of years I find that this growth has been continuous, and I feel sure that it will be of interest to show in some detail the steps by which the primary business of the Post Office—that of carrying the correspondence of the country—has grown to its present dimensions. Into the early history of the letter post I do not propose to enter. It is a subject which has received and is still receiving much attention in my department; and I have been able during the past year to make arrangements whereby the voluminous archives of the Post Office, going back to the period of its first foundation, will be rendered more accessible to research. In the present report I have taken as my starting point the year before the establishment of uniform penny postage. In that year (1839) the number of letters (including six million "franks") which passed through the post was 82,000,000, and in the following year, under penny postage, it rose to 169 millions. At that time the newspaper post was already in existence, but no statistics of the number of newspapers carried are forthcoming. Up to 1855 newspapers were subject to a compulsory stamp duty which enabled them to pass free by post. From 1855 to 1870 they were not required to be stamped, but stamped newspapers passed free from other postage. Before 1870, however, other changes had been introduced into the postal service. In 1848 the book post was instituted at a rate of 6d. per pound, reduced in 1855 to 1d. for 4oz., and circulars were admitted to this post in 1856. The inland pattern post was established in 1863 at a rate of 3d. for 4oz, but this was reduced almost at once to 2d., and early in 1870 to 1d. for 4oz. Up to 1870 then, or during the first 30 years after the introduction of penny postage, the changes in the postal rates had not been extensive, but in 1870 changes greater than any which had occurred since the reform of 1839 were made. On October 1, 1870, postcards were introduced; the rate for book packets and samples was reduced to ½d. for 2oz.; and the rate for newspapers was fixed at ½d. irrespective of weight. In the following year the letter rate of postage, up to 12oz., was reduced to the present scale of 1d. for the first ounce, ½d. for the second ounce, and an additional ½d. for each additional 2oz. The sample post was abolished at the same time. The rates of postage for letters were not again altered till 1885, when postage on weights above 12oz. was reduced to ½d. for each additional 2oz. The book and newspaper rates have since remained unaltered, but a great stimulus was given to the book post in 1892, when greater freedom was given both in the mode of packing and in the definition of a book packet. To complete this summary of the changes of the conditions of the post it ought to be added that the price of postcards and the conditions of their use have been changed from to time since their first introduction in 1870. In 1872 a charge of ½d. a dozen in addition to the stamp was was made. In 1875 stout cards were first issued, and the charge for thin cards was raised to 1d. a dozen. In 1889 the present rates—viz., 1d. for 10 stout cards and ½d. for 10 thin cards—were fixed, and stout cards began to displace thin cards to the extent of 18 millions a year. On September 1, 1894, private cards first passed under a halfpenny adhesive stamp. Cards of "Court" size were issued on January 21, 1895. In consequence of these various changes, in 1894-95 the number of postcards of all sorts rose from 272 to 313 millions, while the number of official postcards showed a decrease of 31 millions. The number of letters and books have perhaps been slightly affected by the re-establishment of the sample post in 1887, and still more by the parcel post, established on August 1, 1883. The penny letter has long been known to be the sheet-anchor of the Post Office, and it is interesting to record that it appears, from returns taken last year, that no less than 95 per cent. of the total number of inland letters passed for a penny each. I am unable to state with certainty what proportion of the 315 millions of postcards delivered last year were official cards, but apparently they are now about half the total number. It will be observed that the total number of postcards has only increased by 0·6 per cent., as against 25·9 last year. This seems to show that the great impulse given to the use of postcards by the introduction of private cards has now spent its force. For the decrease in late years in the number of newspapers passing by post I am unable to account, but I presume that it is due to increased energy and improved system on the part of the great newsagents. From a revenue point of view the tendency to relieve the Post Office of the duty of distributing newspapers is no matter for regret, for, as has been often stated in public, the State loses much money by the work.

Parcel Post.—The number of parcels delivered in the United Kingdom during the year 1895-96 has increased by 5·9 per cent., from 57,136,000 to 60,527,000. The average postage per parcel is now 5·44d., of which the Post Office share is 2·86d. There has been no extension this year of the system of night mail coaches for the conveyance of parcels, but the total of parcels so conveyed has been largely increased. The total number of rail-borne parcels during the year was 52,196,217, an increase of 5·3 per cent. on last year, whereas the number of road-borne parcels was 8,331,221, an increase of 9 5 upon last year. The mild character of the winter enabled the coaches to maintain a regularity which compares favourably with the mail trains, and the mishaps were few and slight.

After referring to the acceleration of general mail services and to the express delivery of letters, the report deals with the money order and savings bank department.

Telegraphs and Telephones.—A very satisfactory increase took place in the number of both inland and foreign telegrams, an increase undoubtedly due to the revival of trade throughout the country. During the year 78,839,610 telegrams of all descriptions were forwarded, showing an increase over the previous year of 7,250,546, or 10·12 per cent.; 64,563,587 of these were ordinary inland telegrams—*i.e.*, excluding foreign, Press, and free telegrams—showing an increase of 5,656,179, or 9·6 per cent. The total revenue from inland telegrams was £2,046,456 as compared with £1,880,206 for the previous year, making the average revenue 7·61d. per telegram, as compared with 7·66d. The number of foreign telegrams dealt with by the Department reached 6,701,838, showing an increase of 764,123, or 12·86 per cent., as compared with the year 1894-95. This total does not represent the whole of the foreign telegraphic business of the United Kingdom. It only shows the number of foreign telegrams transmitted by the Post Office, and does not include those dealt with by the various cable companies without recourse to the postal telegraphs. 5,915,646 telegrams were transmitted at the Press rates for newspapers, clubs, etc., being an increase as compared with the previous year of 513,863, or 9·5 per cent. The average weekly number of words contained in these telegrams was about 13,650,000. Telegrams sent on behalf of the various Government departments show an increase of 22,722, or 8·33 per cent, the total for the year being 295,371, as compared with 272,649 for the previous year. The number of telegrams sent free of charge on behalf of the railway companies amounted to 1,338,818. This number represents an increase of 27·74 per cent. on the number, 1,048,064, sent in the previous year; but it is considerably below the numbers sent in former years before the arrangements for limitation of the number transmissible free of charge, to which reference was made in the reports for 1892-93, 1893 94, and 1894-95, came into operation. In continuation of these arrangements, a settlement has been arrived at with the Great Western and the Brecon and Merthyr Railway Companies for a limitation of their free message privilege, and there now only remain four companies with whom agreements have not been concluded. The numbers of the various kinds of telegrams as compared with the number in the previous year are given in the following table:

Class of telegram.	Number 1895-96.	Number 1894-95	Number Increase.	Receipts 1895-96	Receipts 1894-95	Receipts Increase
				£	£	£
Ordinary inland.	64,563,587	58,907,408	5,656,179	2,046,456	1,880,206	166,250
Press (inland)	5,915,646	5,401,783	513 863	124,881	119,061	5,820
Foreign.	6,701,838	5,937,715	764,123	331,717	286,215	45,502
Railway free ...	1,338,818	1,048,064	290,754	—	—	—
Railway half-rate	24,350	21,445	2,905	469	414	55
Government, free.....	295,371	272,649	22,722	—	—	—
Totals...	78,839,610	71,589,064	7,250,546	2,503,523	2,285,896	217,627

The London local telegrams show an increase of 644,921, or 10 14 per cent., the numbers for the year being 6,999,402 as compared with 6,354,481 in 1894-95.

New Cables.—The large increase in the number of telegrams passing over the Government cables to the Continent, and in the number of conversations on the telephone circuits between London and Paris, has rendered it necessary to consider the advisability

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of improving the means of communication. With the cordial co-operation of the German Post Office, experiments were made with a view to improve the carrying capacity of the cables to Germany by the method of duplex working which has been employed with success on some of the Anglo-French cables; but, owing to the greater length of the Anglo-German cables, the results obtained were not sufficiently successful to justify the adoption of the system for practical working. Arrangements have now been made for the laying of three additional cables to the Continent—two to France, and one to Germany. These cables, each of which will contain four conductors, will afford a much-needed relief to the traffic, and it is expected that this new cable to Germany will prove suitable for duplex working.

Telephones.—The new agreement with the National Telephone Company, embodying the arrangement arrived at after prolonged and difficult negotiations extending over nearly four years, was executed on March 25 last. In accordance with the terms of the Treasury minute, on which the negotiations were based, the agreement restricts the operations of the company to local areas and places the trunk wires connecting those areas in the hands of the Post Office. Special facilities for using the telephone in connection with the telegraph and postal services are placed at the disposal of the public whether subscribers of the company or not. Thus, messages may be telephoned (1) for transmission over the postal telegraphs and delivery as telegrams; (2) for delivery as express letters; (3) for transmission and delivery as ordinary letters. The telephone may also be used for obtaining the services of Post Office express messengers. After considerable labour the experts appointed by the Post Office and the National Telephone Company to value the trunk wires of the company brought their work to a successful termination, the price agreed upon being £459,114. 3s. 7d. This amount was paid to the company on April 4 last. The length of trunk line taken over was 2,651 miles, and the length of wire about 29,000 miles. It has not yet been found practicable to transfer the working of the whole of these wires to the Post Office, as the special arrangements for leading in the wires, and fitting the necessary switchboards, etc., must necessarily occupy some time. The only wires the working of which has at present been transferred are those in the South of England. It is anticipated that the working of the whole of the remaining wires will be in the hands of the Post Office by the end of the summer. The telephonic service on the main system of trunk lines erected by the Department itself between the principal business centres of the United Kingdom to supplement those which it has now acquired from the National Telephone Company, was successfully inaugurated on June 12, 1895 On July 16, 1895, the system was thrown open to the public, and there has since been a steady development of the business. During the year additional telephone circuits between London and Bristol, London and Southampton, London, Lowestoft, and Yarmouth, and London and Guildford have been completed, while further circuits between London and Birmingham, Liverpool and Manchester, Manchester and Carlisle, and Newcastle and Carlisle are in course of construction.

Trunk Wire Charges.—The scale of charges for trunk line conversations of three minutes each has been revised. Under the scale laid down in the Treasury minute of May 23, 1892, the charges were as follows: for 20 miles or under, 3d; for 40 miles or under, 6d.; for every additional 40 miles or fraction thereof, 6d. Under the revised scale the charges are: for 25 miles or under, 3d.; for 50 miles or under, 6d.; for 75 miles or under, 9d.; for 100 miles or under, 1s.; for every additional 40 miles or fraction thereof, 6d.

Coast Communication.—Further progress has been made in the work of telegraphically connecting coastguard stations, etc., on exposed parts of the coast with the nearest lifeboat stations for the purpose of summoning assistance to vessels in distress; and I understand that the system has on several occasions been the means of saving life. Cables have also been laid to the Formby lightship and the pile lighthouse on the Maplin Sands. Some difficulty has been experienced in maintaining the cables which, on the recommendation of the Royal Commission, have been laid to some of the lightships. The cables become chafed and strained, and frequently break. Experiments are, however, about to be made with a view to establish communication with a lightship by means of induction, with a non-continuous cable, and it is hoped that these experiments will have a satisfactory result.

Profit on Post and Telegraph.—From the financial point of view the past year has been one of unexampled prosperity in the Post Office. The General Election and the revival of trade have combined to enable me to realise a profit of £3,632,122 Your lordships will, I doubt not, recognise in these figures a proof that my department continues to be administered upon the lines laid down by the Select Committee of the House of Commons in 1888, which dwelt upon "the necessity of working in the main upon business principles, and with a view to a profit on the transactions of each year," and added "that the high business character of the Post Office Department is no small degree due to the fact that it has been administered in this spirit and from this point of view.

BLACKPOOL CORPORATION ELECTRICITY SUPPLY.

We have received Mr. R. C. Quin's report as to the condition of the plant and system of working at Blackpool, together with suggestions as to modifications and improvements thereto. As the report is a long one, and in many cases enters into details not of interest to the general public, we have been obliged to condense it somewhat liberally. The report is addressed to the chairman and members of the Electric Lighting and Tramways Committee, and commences as follows:

Gentlemen,—Acting under your instructions I have carefully examined the state of the machinery and mains, and considered the present conditions of the supply both electrically and commercially. I would first remind you that I am not a partisan of either continuous or alternating systems of supply, believing that each case must be judged entirely on its own merits, and the system adopted which is most applicable to the particular town. Taking all the circumstances into consideration, it seems to me that the committee were well advised in adopting the high-pressure alternating supply. But I am not satisfied that the plant and machinery were the best that could have been used, nor that the class of mains, their method of laying, and the system of mains generally, were the best calculated to give a reliable and economical supply. In saying this I need hardly point out that I am not concerned as to the personality of the party or parties responsible for the blunders which have been made, but am dealing simply with the existing facts.

Buildings.—The committee are already aware of the state of the engine-room walls carrying the travelling crane, and of the necessity of a considerable expenditure to repair these and supply new girders for the traveller rails. The drainage is also in a very bad condition, due to the fact that there has hitherto been no suitable outlet, necessitating the drainage of the works to a low-level sump and the pumping from this to the higher level of the sewer. I have consulted with the borough surveyor on the subject, and he advises a connection being made to the new sewer in Bonny-street. This will obviate the necessity at present existing of running a steam pump for 24 hours daily.

Plant.—With regard to the engines and dynamos, none of these can be termed "highly efficient," the best set giving under 75 per cent. at full load, while the day set (No. 3) on half load (its usual output) gives only 35 per cent. efficiency. Only two of the engines can govern passably, the governors on the remaining engines being absolutely useless. When we consider the very large floor space occupied by this class of plant and the consequent large outlay needed for buildings, etc., together with their inefficient working, I am afraid the committee will regret their choice. I would not, however, recommend the replacing of this plant, seeing the very large amount of idle capital it would entail, but would suggest the provision of a new day set (a Parsons turbine) giving us something more than 35 per cent. efficiency, and the adoption of electrical governors for the remaining plant (excepting Nos. 7 and 8). The new 300 kilowatt Ferranti set now being installed has a guaranteed efficiency of 84 per cent.

Mains.—As I have previously said, the system of mains is not the best that could have been devised. There are five separate high-tension alternating circuits, the connections to the houses being either by transformers placed in boxes under the pavement or by transformers placed in the basements of houses. Very little distributing cable is employed. The disadvantages which this entails may be thus summarised: (1) No new premises can be connected without cutting off supply entirely from the circuit, which probably means leaving 70 or 80 customers without light during the time so occupied. (2) The continuity of the supply to a great number of customers depends entirely upon the maintenance in working order of one cable—a very risky proceeding, seeing their present state. (That Mr. Hesketh's opinion on this point is pretty much in accord with mine is proved by the following extract from his report of December 7, 1895, where on page 9, under the head of cables, he says: "Experience proves that it is not wise to have too great a load dependent upon any single cable.") (3) Generally speaking, every additional customer means increased current losses, since he must have a transformer, and current must be supplied to keep the transformer in working condition, whether the customer is using his light or not. The last condition even now means a considerable waste, for of the 35 per cent. obtained during the 20 hours of light load, from the day set, nearly 70 per cent. of this 35 per cent. is current needed to keep the numerous transformers in condition to supply current, and for which we get no return. Therefore the efficiency of supply during 20 hours of the day is only 11·5 per cent., and this allows nothing for steam-pipe and boiler losses—a very considerable item. This problem must at once be attacked, seeing that the transformer losses, under the present conditions, increase with the addition of customers.

Then as to the condition of the cables—upon the good working of each individual one of which so much depends—I find that the general rule in force here seems to have been to ram and jamb as many cables into one iron pipe as could be got by sheer force. At least that is the impression one gets from the results. In one 4in. pipe there are five high-pressure circuits (four of 2,000-volt alternating and one of 3,000-volt continuous)—that is to say, 10 single rubber insulated cables—how they were drawn in is a mystery to me. (As evidence of this see Mr. Hesketh's above-mentioned report, where on page 2 he says: "There are laid in the town 6 miles 650 yards of main piping, into which have been drawn 39 miles 1,350 yards of cable.") This gives an average of something over six cables per pipe. I have examined their condition, where they are visible at the draw boxes, and find the rubber in a great many places has perished. As sure as fate, if one cable breaks down the whole lot will follow suit. This is only one instance, but it is a fair sample of the state of affairs over

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the whole town. The high-tension rubber cables have perished on all sides, and must be replaced by more lasting ones and different methods adopted of laying them. The arc lighting cables are similarly situated—that is to say, for practically their whole length they are drawn in the same pipes as high-pressure alternating cables. The condition of these arc cables is very bad—in fact, I do not think there is 100 yards out of the 11¼ miles laid which is worth more than its price as scrap copper. The repeated street-lighting failures are evidence of this deterioration. Of course, the breakdown of one cable in nine cases out of ten means the burning asunder of the other cables contained in the same pipe. Clearly, therefore, such a state of things cannot be allowed to exist. I attribute these failures to the action of the salt water; the pipes containing these cables being practically cisterns filled with muddy sea-water. The inter-chemical action between sea-water and iron pipes, and sea-water and rubber, and sulphates and chlorides, etc., of iron (formed by the action of the sea-water) upon the rubber readily account for its rapid deterioration. In my opinion neither rubber-covered cables nor iron pipes should have been used such circumstances, and I recommend their entire replacement by lead-covered cables laid in asphalte about 1ft. beneath the surface of the pavement [Note.—Since writing the above, I have been informed by Mr. William Chew, the assistant gas manager, and formerly your electrical engineer, that in the year 1879 or 1880 a similar breakdown was experienced. This was in the days of the first arc lighting of the promenade from the tall masts. Originally, the cables, which consisted partly of lapped rubber and partly of vulcanised rubber, were drawn in iron pipes. Within about 12 months of their being laid they had to be withdrawn from the pipes and suspended from posts, and when the new cables, having guttapercha insulation, were laid in wooden troughs filled with asphalte the trouble was overcome. It seems strange to me having had such an experience in 1880, the Electric Lighting Committee or their advisers should have committed the same error in 1893.] This is, in my opinion, the only method by which a sound and lasting main is to be obtained under the existing conditions. It is possible that the present alternating mains could be worked for, say, another six months, or at the outside 12 months, but this would place us in the very unsatisfactory position of continually expecting breakdowns and consequent stoppages of supply until the repairs were made. And not only would this result in a considerable loss of revenue, but public confidence in the reliability of our supply would be further shaken, and the replacement of electric light by gas would be brought about in numerous instances.

Transformer-Chambers.—With regard to the position of the transformers and the current losses entailed by their indiscriminate use, I propose to build, under refuges or pavements, in different parts of the town, transformer-chambers, each containing a number of transformers; the positions of these to be hereafter arranged with the borough surveyor. Each transformer chamber would be connected by a high-tension feeder direct from the works, and by inter-connecting cables to its neighbouring chambers. The supply to the houses would be by a network of low-tension cables completely connecting the transformer-chambers. By this arrangement we get an absolutely reliable supply, since it is independent of the good working of any one high tension cable, or of any transformer-chamber. As regards economy of working, it is obvious that, having the transformers completely under our control, we can suit their number and capacity to the demand, thus obtaining the most efficient conditions for working transformers. Further, we make the supply very much safer for the general public.

Plans and Estimates.—Plans showing the proposed rearrangements of the mains and positions of transformer-chambers have been made and are open to your inspection. I estimate the additional cost of modifying the high-tension mains to be £1,200, of low-tension mains £3,000, and of transformer-chambers £1,300, a total of £5,500.

Local Conditions Affecting Electrical Supply.—As the committee are very well aware, and as I need hardly point out, the conditions of the supply of electricity in Blackpool are very peculiar. For three months of the year the demand is equal to the capacity of the generating plant, but for the remaining nine months the maximum demand is less than half the summer demand. The yearly maximum is reached at the lightest season of the year, and therefore the length of time during which it is required is very short, whereas had this maximum been reached in winter the sale of electricity during that time would have been equal to three times as much.

System of Charging.—To encourage the winter demand the following new scale of charges is proposed: The charge for electricity consumed in the half-years ending June 30 and December 31 will be at the rate of 8d. per unit until the amount equals that required for a use of the consumers' demand for 182½ hours in the half-year—that is to say, for one hour per day on the average. All electricity consumed in excess of this quantity will be charged at the rate of 2d. per unit, provided always that the minimum charge for current to any consumer will be 10s. in any quarter. The consumer's demand will be taken to be the mean of the two monthly maximum rates at which electricity has been consumed in the months of April, May, and June of the first half-year, and July, August, and September of the second half year, and will be determined by the consumer's demand indicator. In order to prevent any single special demand for electricity raising the number of units chargeable at 8d., the consumer may, in the event of his intending to burn a number of lamps in excess of his usual maximum, on any such occasion (with the exception of the months of July, August, and September, and not exceeding once in each month) give 24 hours' notice in writing to the Corporation, and they will thereupon take steps to prevent the consumer's demand indicator from registering on the occasion so notified.' The cost necessary to carry out this reform in charging is comparatively very small, considering the large amount of capital affected by it. The cost of installing these maximum demand indicators works out at £700—that is, 1 5 per cent. on the capital at present invested, and as the whole aim of the system is to make such capital more productive, and as it strikes at the root of the difficulty, it must be admitted the expense of carrying it out is proportionately very little.

200-Volt Distribution.—It was not until recently that the Board of Trade, recognising the many advantages both from the consumers' and suppliers' point of view, and at the practically unanimous request of the electrical profession, consented to allow an alternating supply of electricity to be delivered to consumers at a pressure of 250 volts. The obvious advantages appertaining to such a system are the reduction of copper in the mains, the increased distance to which electricity can be transmitted with the same loss of power, the necessity for fewer transformer-chambers, and the reduction in the cost of meters, etc., inasmuch as by doubling the pressure we halve the current for the same power. The present condition in which we find ourselves, unfortunate though it is from many points of view, has at least one side a little less gloomy than the rest. I refer to the absence of any large sum of capital sunk in distribution at 100 volts, and the consequently comparatively small outlay now needed to adopt a higher pressure of supply, and thus reap the above-mentioned advantages. After carefully weighing the *pros* and *cons.*, I recommend that the pressure of supply be raised from 100 to 200 volts, and distributed on the two-wire system. This change of pressure will necessitate the replacing of the 100-volt lamps by lamps made for 200 volts, and I estimate that this will cost about £650. I would point out that the estimates for low-tension network, transformer-chambers, demand-indicators, etc., are based upon the assumption that the 200-volt distribution will be adopted. Should, however, it still be decided to distribute at 100 volts, and which I should very much regret, the above-mentioned estimates must be increased by 30 to 40 per cent. I would suggest that immediately after the meeting of the Council next following the decision of the committee, permission be obtained from the Board of Trade and public notice given of the proposed increase of pressure. That after the date of the expiration of such notice, all new consumers be supplied at 200 volts, and that steps be taken during the coming winter to place the whole supply on the basis of 200-volt distribution.

Supply to Tramways.—That there should be two entirely separate and distinct electricity generating stations within a town, owned and worked by the same body, one for power and the other for lighting, seems to be rather an anomaly. Moreover, it is by no means economical, entailing as it does the employment of two separate staffs for the one purpose. Further, as regards the lighting works, for the greater portion of the day the plant is practically idle, whereas it could be profitably utilised for working the trams. What I therefore suggest for the committee's consideration and sanction is the transference of the two Crompton dynamos from the tram-shed and their erection here coupled direct to a high-speed engine of approved type. The estimated cost of this inclusive of foundations, fixing, etc., is £500 Further, in view of the extension of the tramways now about to be carried out, I should deem it advisable to instal an additional 100 unit Parsons turbine combined with a continuous-current generator so arranged that it could supply either at 250 volts or 500 volts. The estimated cost of the latter is £1,100, and it would increase the electrical output of the tramways plant to more than double its present capacity. In addition to this there would be required a main connecting the electricity works to the tram-shed, and a further extension of the switchboard. These would cost about £200 and £250 respectively. No extensions of the present electric lighting buildings would, however, be necessary. Altogether, therefore, the further capital expenditure incurred by the suggested transference of the generating plant from the tram-shed to the electricity works would be about £2,050. The borrowing powers sanctioned for tramway purposes covers an amount larger than this, so that no application to the Local Government Board in this respect need be made. I have very carefully gone into the question of the cost of supplying current under such conditions from these works, and I have no hesitation whatever in saying that we can guarantee the maintenance of the necessary supply of current to the tramway department at 2½d. per unit, and at the same time leave us a satisfactory profit. Calculating the probable units to be sold to the tramways department at 130,000 per annum, this would effect a saving in their revenue account to the extent of £270 upon the year's working, and leave us a profit of about £500. In other words, the saving to the Corporation annually would be at least £700 if taken on the basis of the present cost of generation. In this connection it will be remembered that the estimated output last year was 128,174 units, so that with the extensions before named it is quite probable that the demand will be considerably over 130,000 units per annum, in which event the saving will increase *pro rata*.

Conclusions.—Annexed hereto (Appendix B) I give a statement of the expenditure of capital—apart from that necessitated by the replacement of the present rubber cables by special lead-covered ones—which I estimate will be involved by the alterations I have sketched out. In conclusion, I cannot too strongly impress upon the committee my sense of the hopelessness of the future prosperity of these works unless some immediate steps are taken to remedy the defects I have already indicated. It is not a question of saddling, or attempting to saddle, the responsibility of past errors

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upon the shoulders of any individual or individuals. It is emphatically rather a question of repairing the errors before they become irreparable. Towards the accomplishment of this object I have given much careful and anxious thought; and the proposals, suggestions, and recommendations I have embodied in the foregoing report will, I firmly believe, if carried out in their entirety, bring the electrical portion of the works up to a high level of excellence, and place the financial future of the undertaking beyond the possibility of failure.

The main points of my report to which I beg to draw my committee's most especial attention are: (1) The replacement of faulty mains; (2) the increase of the pressure of supply; (3) the adoption of demand indicators; and (4) the transference of the tramways supply to the electricity works from the present tram-shed. By these means there will be brought about, in my opinion, the absolute reliability of the supply, the economical working of the plant, the minimising of the financial risk, and, generally, a great saving to the Corporation by the fuller utilisation of the resources of the electricity works. I feel I should have failed in my duty had I not most fully put the case before the committee, and, without blinking any facts, gone to the root of the trouble, and shown exactly what it is and how it can be remedied. It is now for the committee to say whether this report is worthy of their acceptance, and whether the electricity works are ultimately to become a success or a failure.

APPENDIX B.—Statement of Unspent Balance of Capital last sanctioned by Local Government Board and the manner in which it is proposed to be diverted.

Balance of Capital Unspent.

Foundations	£80
Boilers, condensers, etc.	2,321
Alternator	3,843
Rectifier	413
Cables and pipes	2,707
Transformers and meters	7
Public lighting	1,556
Coal bunkers, test-room, stores, tools, and general expenses	1,038
	11,965
Less amount overspent on steam-pipes, etc., £226, and switchboard and instruments, £50	276
Approximate total	£11,689

Proposed Diversion.

New drainage scheme, as per borough surveyor's plans and estimates	£400
Covering of boilers and steam-pipes	100
One new 50-kilowatt Parsons turbo-alternator	650
Three new electrical governors fitted complete at, say, £50 each	150
Additional high-tension mains for the inter-connection of the present system along Dickson-road; from works to Church-street *viâ* Coronation-street; from works to Park-road; along Station-road and Alexandra-road, laid complete, say	1,200
Low-tension cable along Promenade, Lytham-road, Waterloo road, Station-road, Victoria street, Church-street (part), Dickson-road, Park-road, Albert-road, and Coronation street respectively, laid complete, say	3,000
New services to, say, 100 consumers, at £10 each complete	1,000
Nine transformer-chambers, fitted complete, say	1,300
Public lighting, provision of 50 arc lamps	800
New coal bunkers, test-room, stores, and general expenses	1,040
Demand indicators, fitted	750
200-volt lamps for increased supply pressure	650
Contingencies, say	649
Approximate total	£11,689

COMPANIES' MEETINGS AND REPORTS.

SUSSMANN ELECTRIC MINERS' LAMP COMPANY, LIMITED.

The statutory meeting of this Company was held on Monday at the Cannon-street Hotel, E C., the Earl of Westmorland presiding.

There was no resolution for the meeting, but the **Chairman** made a brief statement as to the progress of the Company during the last four months. The directors were in negotiation with Belgium, South Africa, and France with regard to the sale of their foreign patents and were shipping sample lamps to India. Many enquiries had been received from different collieries both in England and Wales. The lamp was absolutely the best lamp yet invented for underground work. The Edison and Swan Company, with whom the Board had arranged for the making of the Süssmann lamp, would be in a position to start the manufacture almost at once.

The proceedings occupied only a very few minutes.

West India and Panama Telegraph Company.—For the half-month ended August 31 the receipts were £1,660, against £1,617 for the corresponding period of 1895.

CONTRACTS FOR ELECTRICAL SUPPLIES

CONTRACTS OPEN.

Rome.—Tenders are wanted by September 9 for the supply of 70 000 battery zincs for the Italian Ministry of Posts and Telegraphs.

Ardenne (Belgium).—Tenders are wanted by September 8 for the electric lighting of the town Application to the Hôtel de Ville, Ardenne (Namur).

Paris.—Tenders are wanted by September 8 for the supply of magneto-electric calls for the Departments of Posts and Telegraphs, rue de Grenelle 103, Paris.

Spa (Belgium) —The Burgomaster and Echevins of Spa invite propositions for undertaking the public lighting, either electrically or by acetylene. The date fixed is September 15. No further information is given in the official advertisement.

Villefranche-Lauragais (France).—The Municipality of Villefranche-Lauragais (Haute-Garonne) have invited competitive plans for a public water supply and electric lighting. Prizes of 1,000fr., 500fr., and 200fr. are offered, under the usual conditions, and schemes must be sent to the Mairie by October 10.

Brussels.—La Société national des chemins de fer vicinaux will receive tenders up to October 28 for the conversion of about 14½ miles of tramway in the suburbs of Charleroi into electric lines on the overhead system. Particulars are obtainable, price 1fr., from the office of the Société, Brussels, rue de la Science 26.

Odessa.—The Municipal Authorities have decided to offer for tender the electric lighting of part of the suburbs and the new prison. No date is given, and application must be made to the Municipal Delegation at Odessa, but certain particulars can be obtained at the Ministry of Commerce (bureau de renseignments commerciaux), Paris, rue de Varenne 80.

Amsterdam.—Up to September 12 the Consul-General of the South African Republic (Transvaal) will receive tenders for the supply of insulators with supports. The address is at Doelenstraat 8, Amsterdam. Specifications will be procured on demand by Mr. F. J. Belinfante, late A. D. Schinkel, Paveljoensgracht, The Hague, at the price of 1sh.

Brussels.—Tenders in connection with the construction of an acetylene generating station at Forest, for La Société anonyme, bruxelloise pour l'exploitation de l'acetyléne pour Raoul Pictet will be received on September 5 (later tenders disregarded). There are six contracts for the different species of work. Application for particulars is to La Société, etc., Brussels, rue Royale 121.

Cologne.—Tenders are required by the Municipal Authorities for the construction and working of electric tramways in the city of Cologne to an aggregate length of 20·3 kilometres (12½ miles). Specifications, plans, and particulars are obtainable for 10 marks (10s.) from der Registrateur B, des Oberbürgermeisteramt, Köln, Germany, and tenders must be in by November 6.

Madras.—Tenders are invited for the lighting by electricity of Government House, Madras, including the banqueting-hall and aide-de-camps' bungalow, and also for the lighting of Government House, Guindy, including the military secretary's bungalow. For particulars application must be made to the consulting architect to the Government, Chepank, Madras. Tenders will be opened on November 11, 1896.

Voghera (Italy).—In view of the expiration of their contract with the local gas company in 1898, the municipal authorities of Voghera are desirous of receiving during the present year propositions for the lighting of the town either by the electric light or a mixed system of gas and electricity. The population is 16,000. Application should be made to L'Administrazione Comunale, Voghera, who will give all particulars necessary.

Mayaguez (Puerto Rico).—The Secretary of State for Foreign Affairs has been informed by H.M. Ambassador at Madrid that the Spanish Government have invited tenders for the construction and working of a telephone system in Mayagüez, Puerto Rico. The date fixed for the consideration of tenders is October 8, and such particulars as have been received may be inspected at the Commercial Department of the Foreign Office between the hours of 11 and 6 daily.

Oldham.—The Electric Light Committee invite tenders for the various works required in the extension and alterations of the buildings of the electric light station in Gas-street, Oldham. Specifications and drawings can be seen. and schedules of quantities obtained, on application to Mr. Arthur Andrew, Gas and Water Offices, Oldham. A charge of £1. 1s. will be made for the schedule of quantities, which will be returned on receipt of a bona fide tender. Tenders to be sent in by September 15.

Blackpool.—The Corporation are prepared to receive tenders for the supply, laying, and maintenance of high-tension and low-tension lead-covered cables and the supply of all necessary jointing sundries. Specifications and bills of quantities, together with forms of tender, may be obtained from the Borough Electrical Engineer, on payment of 10s. 6d, which will be returned on receipt of a bona fide tender. Tenders, addressed to the Chairman of the Electric Lighting and Tramways Committee, and endorsed "Tender for Cable," should reach the offices of Mr. Robt. C. Quin, borough electrical engineer, Corporation Electricity Works, Blackpool, not later than September 8.

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Hull.—Pending the decision of the Town Council as to the leasing of the tramways or the working of them by the Corporation, tenders are invited for a license to temporarily work and use the tramways for one year from October 15, 1896, upon the terms and conditions embodied in the draft of an agreement, which can be obtained by application to Mr. R. Hill Dawe, town clerk, Town Hall, Hull. Tenders, stating the amount of rent offered, must be delivered at the Town Clerk's Office, by 10 a.m. on September 21, in sealed envelopes, endorsed "Tender for Temporary Working of Tramways."

Cadiz.—The Secretary of State for Foreign Affairs has received dispatches from her Majesty's Consul at Cadiz, stating that preliminary tenders for a supply of electric lighting apparatus for the illumination, on the most approved modern plan, of private houses, etc., in the town of Cadiz are invited by the "Sociedad Co-operativa Gaditana de Fabricacion de Gas." It appears that the tenders should be sent in by September 15 to the above-named company, whose offices are San José, 25, 27, and 29, Cadiz. Firms wishing to obtain the contract for the supply of plant are advised by the Consul to send representatives to treat personally with the company. Such additional particulars as have reached her Majesty's Government on the subject may be viewed at the Commercial Department of the Foreign Office, any day between the hours of 11 a.m. and 6 p.m.

Cork.—The Mayor, Aldermen, and Burgesses of the city or borough of Cork invite tenders from persons or companies willing to carry into effect the powers conferred upon the Corporation of Cork by the electric light provisional order of 1896. The Corporation of Cork have made arrangements with a tramway company, who propose installing an electric tramway system in Cork, whereby the supply of current for the tramways must be taken by the tramway company from the assignees of the electric light provisional order, and the advantages of this arrangement are specially pointed out to the intending tenderers. A copy of the conditions under which the order may be transferred, and form of tender, prepared by Messrs. Kincaid, Waller, and Manville, may be obtained from Mr. Alexander M'Carthy, town clerk, Municipal Buildings, Cork, on payment of £1. 1s., which sum will be returned on receipt of a bona fide tender. Sealed tenders, endorsed "Application for Transfer of Electric Light Provisional Order," to be sent by 12 noon on September 11 to the Town Clerk.

RESULTS OF TENDERS.

Estepa (Seville).—The electric lighting contract for this place has gone to the Faro de San Vincente Company at 7,500 pesetas annually for 10 years.

Paris.—For the limited competition for armoured cables, etc., in the avenue de l'Opera, the contract has gone to the Société industrielle des téléphones.

Altona.—The accepted tender for the supply of a 12-ton electric crane for the Prussian State Railways at Altona on August 17 was that of Carl Schenck, Darmstadt, at 7,450 marks (about £372. 10s.).

Cassel.—For the contract for 80 incandescent lamps and 14 arc lamps for the municipal authorities the lowest tender was that of the Allgemeinen Elektricitätswerke, Hanover, at 5,465 marks. There were eight tenders in all.

The Hague.—For the supply to the Dutch Colonial Ministry of 2,700 iron telegraph posts on August 26 the lowest tenders were those of the Prins van Oranje Ironworks at The Hague. For galvanised iron wire, insulator pins, etc., the lowest tender was from Messrs. R. S. Stokvis and Son, Rotterdam.

Islington (London).—The tenders for the enlargement of the central electric lighting station, Eden-grove, Holloway-road, N., for the Vestry of St. Mary, Islington (Mr. A. Hessell Tiltman, F.R.I.B.A., 6, John-street, Bedford-row, W.C., architect), were as follows:

G. Sharpe, Gilbens-road, Stratford, (accepted)	£7,540
Munday and Son, Catherine House, Trinity-square, Tower-hill	7,690
Thompson and Beveridge, 191, Euston-square, N.W.	7,940
Leslie and Co., Limited, St. James House, Kensington-square	8,015

BUSINESS NOTES.

Holywell (Wales).—The new line of telegraph from Holywell to Halkin has been opened for the transmission of telegraphic messages.

Epsom.—The Urban District Council have appointed Mr. W. C. C. Hawtayne, of 20, Bucklersbury, E.C., as consulting electrical engineer.

Londonderry.—Mr. Christie, electrical engineer, has presented his report to the Lighting Committee. It dealt mainly with the rearrangement of certain lamps, and was duly adopted.

New Address.—In future the offices of the Brockie-Pell Arc Lamp Company, Limited, will be at 97, Queen Victoria-street, E.C., to which address all communications should be sent.

Western and Brazilian Telegraph Company.—The receipts for the week ending August 28, after deducting 17 per cent., payable to the London Platino-Brazilian Telegraph Company, were £2,791.

Tiverton (Devon).—A promenade concert and exhibition of electrical appliances has been held at Broomfield, the residence of Major Gardner, in aid of the funds of the Tiverton Infirmary and Dispensary.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending August 30 amounted to £1,300, as compared with £1,272 in the corresponding week of the previous year, being an increase of £28.

St. Pancras (London).—The Vestry have sealed an agreement with Messrs. Shoolbred and Co., of Tottenham Court-road, in regard to the laying of two pipes under that thoroughfare, between Nos. 116 and 154, for the conveyance of electric lighting wires.

Blackpool.—Mr. R. C. Quin's report on the position of matters at the town electricity works has been adopted by the Town Council, and the considerable alterations and extensions recommended are to be carried out. Mr. Quin's report is given in full elsewhere in our columns.

The City Polytechnic.—We have to note the receipt from the City of London College, White-street, Moorfields, E.C., of the syllabus of lectures in the engineering department under the guidance of Mr. H. Adams, M.I.C.E. The college calendar will not be obtainable till October.

City and South London Railway.—The returns for the week ended August 30 were £835, compared with £786 for the corresponding period of last year, being an increase of £49. The total receipts for the half-year 1896 were £8,333, compared with £7,669 last year, being an increase of £664.

Taunton.—The Lighting Committee have decided to continue the arc lamps along the upper end of Calverley-road, and place one in Monson-road, making four in all. These are to be alternating-current arcs, and if they are found satisfactory no more rectifiers will be put down at the generating works.

Automobiles.—Messrs. Whittaker and Co. are about to issue an authorised translation of Mr. D. Farman's recent and well-known work upon "Automobiles." It will be fully illustrated, and contain constructional details of the latest work. The translation has been carefully done by Mr Lucien Serraillier.

Bridlington.—The attention of the Highway Committee of the District Council having been drawn by Mr. W. C. Townsend to the erection of telephone wires by the Telephone Company and private users from their houses to business premises, a committee has been asked to report as to the powers of the Council in such cases.

South Shields.—There was little ceremony at the inauguration of the electricity works on Tuesday. The current was switched on by the Mayor, and an adjournment was afterwards made to the town hall, where a few speeches took place, and the healths of the Electric Lighting Committee, the engineer, and contractors were proposed and responded to.

Aluminium.—The British Aluminium Company having started the production of aluminium at their works at Foyers, according to *Aluminium and Electrolysis*, the quality has been found to be exceptionally good, and compares very favourably with the foreign metal hitherto sold. The company are now the only manufacturers of the metal in the United Kingdom.

Windermere.—Subject to the approval of the Highway Committee, the District Council have agreed to seal a contract with Messrs. R. H. Fell and Son for the electric lighting, the Council to pay £1. 6s. 9d. per lamp per 1,000 hours, including the cost of the incandescent lamps, but excluding that of the globes and fittings, which would cost £1. 18s. per set.

Dover.—The use of motorcarts in connection with street scavenging has been under discussion by the Town Council, and it was decided to delay, pending further information on the subject, the erection of extensive stabling accommodation on land the Council have purchased for a scavenging depot. The borough surveyor will report on the tramways scheme in a fortnight.

Coatbridge (Lanark).—At a special meeting of the Town Council it was reported that the Scottish House-to-House Electricity Company had declined to light the arc electric lamps in the streets at 15s. per lamp, and the Council remitted the matter to the Lighting Committee, with powers to come to the best arrangement possible with the company so as to have the lamps lit.

New Company.—The Northern Electrical Engineering and Plating Company, Limited, has been registered, with a capital of £1,000 in £1 shares, to carry on the business of electrical and general engineers, electroplaters, shipbuilders, machinists, fitters, founders, millwrights, smiths, wire-drawers, metallurgists, and metal merchants. The office is at Brewery-lane, South Shields.

Exeter.—The electric light company has been summoned before the local magistrates for the non-payment of £3. 18s. 0½d. poor rate. The demand note was served on the secretary to the company, but it appeared that the summons was served on Mr. Knill, who is a receiver on behalf of the debenture-holders, and not an official of the company. The result of this was that the Bench dismissed the case.

Douglas (Isle of Man).—The opening of the Upper Douglas Cable Tramway, which has been promoted by the Isle of Man Tramways and Electric Power Company, Limited, to deal with the traffic from the Victoria Pier, Douglas, to the north end of the town, was celebrated by a public demonstration. The reason of the adoption of cable rather than electric traction on this piece of line is the extreme severity of the gradient.

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Cork.—The premises at the "Wonderland" Bazaar will be lighted throughout by electricity. Messrs. Handley and Shanks, 33, Patrick-street, Cork, have been entrusted with the work. The total number of lamps will be over 300. For outdoor illumination six 2,000-c.p. arc lamps will be used The plant necessary for producing the current required will consist of one steam-engine, 30 i h.p., two gas-engines and three dynamos.

Havre (France).—Messrs Lazare, Weiller, et Cie. have just started at Hâvre important works for the manufacture of copper, bronze, steel and iron wire, and French wire nails, and their English agent, Mr. F. Espir, informs us that they are ready to enter into contracts for delivery after October 1 next. The motive power of the new works, which is equal to more than 3 000 h.p., is entirely distributed by electricity, and there are about 120 motors employed in the different shops.

Bolton.—At the meeting of the Gas and Electricity Committee, the electrical engineer has reported that the cable for the supply of electricity in Bromwich-street, Haulgh, would be commenced immediately. He also reported an application for a supply of electricity at the Park Sawmills, Spa-road, and it was agreed to lay the requisite mains subject to the number of lamps taken being satisfactory. It was decided to purchase an incandescent street-lighting apparatus as a test.

Northwich.—The Urban District Council have sealed an agreement with the newly formed Northwich Electric Supply Company, who have applied to the Board of Trade for powers to supply electric light in the rural and urban districts. The principal clause in the agreement gives the Council the option of purchasing the concern at the end of 14 years on repayment of expenditure incurred in buildings and plant and the payment of 7½ per cent. for any year when a less dividend has been declared.

Catalogue.—We have received from Messrs. John Davis and Son, of All Saints' Works, Derby, their catalogue of mining, surveying, engineering, and mathematical instruments. It may be noted that Messrs. Davis and Son state that further experience in the use of aluminium has confirmed their opinion that that metal properly alloyed is invaluable for surveying instruments. In the catalogue the principal instruments and apparatus have attached a cable-code word for the convenience of foreign orders.

Kingston-on-Thames.—The electric lighting capital account, as presented to the Town Council, shows that loans amounting to £23,772 have been raised, of which £7,722 has been lent during the past year. The capital expenditure has been as follows: for buildings, £4,279. 9s. 5d.; machinery, £11,180. 15s. 8d.; mains, etc.. £6 748. 19s. 3d.; transformers, £630; meters, £667. 14s. 4d.; electrical instruments, £86. 0s. 5d.; sundries, £268. 14s. 1d.; which, with the cost of loans, etc., £114. 15s. 8d., makes a total of £23,974 8s. 10d.

Appointments Vacant.—The Council of King's College, London, are open to receive applications for the post of demonstrator of mechanical engineering. Particulars can be obtained on application to the Secretary.—A head master is wanted for the Banbury Technical School, but science and technology do not appear to be the most important qualifications. Application may be made to Mr. Whitehorn, Municipal School, Banbury.—The Blackburn Corporation want an assistant electrical engineer at £125 a year. Application is to the Town Clerk

Tunbridge Wells.—At the Town Council, in moving the adoption of the report of the Lighting Committee, Mr. Ashby Wood was asked some questions. Mr. Gower desired to know whether the new system of lighting already paid or was a loss to the borough? Mr. Wood replied that, although a year had not yet passed, the proceeds of the new electric light paid the sinking fund and the rate of interest if there was no profit as yet. Therefore, the town was to be congratulated, seeing that in some towns they had a loss on the new works for several years. There had been great progress in the adoption of electricity by all classes for houses and shops, and he hoped that they would soon see a profit for the Corporation.

Fresnes-les-Rungis (France).—Further particulars have been published as to the competition for schemes for lighting the prisons at Fresnes-les-Rungis, in the Department of the Seine. A complete installation is required for 2,500 10-c.p. and 600 16 c.p. incandescent lamps and 50 10-ampere arc lamps, with provision for a possible addition of 500 extra incandescent lamps in the future. The boilers must also provide power and heating for the laundry, baths, etc. Either an alternating or a continuous current plant is admissible, but provision must be made for running in parallel, and the distribution must be on the three-wire system at 110 volts between the exterior and neutral wires. The estimate for the work is put at 254,305fr. as a maximum, which must not be exceeded.

Failure.—The first meeting of the creditors of Paterson and Cooper has been held. The debtors were electrical engineers, carrying on business at Prince's-mansions, Victoria-street, and Dalston, and also at Glasgow. The receiving order was recently made, and a special manager was appointed with a view to the completion of certain contracts. The statutory accounts were not filed, but the Official Receiver said that, from figures furnished to him by the debtors, and which must be accepted with reserve, it appeared that the unsecured indebtedness was estimated at about £11,000, and the assets at £18,000, in addition to interests in certain patents. The debtors made no proposal, and a resolution for bankruptcy was passed. Mr. Edward Moore, accountant, was appointed trustee of the estate, together with a committee of inspection.

Electrical Undertakings.—Under the title of a "Manual of Electrical Undertakings," a new annual is to be issued in October next by Messrs P. S. King and Son, King-street, Westminster. The annual will be compiled under the direction of Mr. Emile Garcke, M.I.E.E., chairman of the Electrical Section of the London Chamber of Commerce, and will contain particulars of the last published accounts of established electricity supply and electric traction undertakings, whether owned by companies or by municipal corporations, and of telegraph, telephone, manufacturing, and other electrical companies; and also particulars of all electrical companies registered since 1856, the year of the first Joint-Stock Companies Act, as well as the names, arranged alphabetically, of the directors and other officials of the various electrical undertakings.

Madagascar.—The Madagascar papers have contained a statement that Mr. Laroche, the French Resident-General, had granted to a Mr. de Coriolis, described as a former member of the House of Commons—he is really a member of the Mauritius Legislative Council—a concession for the construction of railways in the island, and to establish electric lighting works. The Paris *Temps*, commenting on this report, says: "It is true that Mr. de Coriolis has made proposals to Mr. Laroche, in the name of the British company of which he is the representative, and that the Resident-General has taken notice of the request by intimating to Mr. de Coriolis that he will transmit the proposals to the French Government. Mr. de Coriolis made a mistake as to the meaning of this reply. His proposals, which have been communicated to the Ministry of the Colonies, will result in nothing."

Brighouse.—The sub-committee appointed with regard to the purchase of the electric lighting plant from Mr. A. B. Brook have presented their report to the Town Council. The sub-committee state that they have had the plant valued by Mr. Blakey, of Bradford, and they have made Mr. Brook an offer of £1,535 for the plant, which has been accepted, and they recommend that the plant be purchased for this amount, Mr. Brook to work the plant at his own risk till the license to supply electricity has been obtained by the Corporation from the Board of Trade, and that afterwards the Corporation take over the plant and pay Mr. Brook £100 per annum for the use of the overhead wires till such time as the Corporation can lay them underground; but the committee are advised that the Board of Trade will not allow these wires to be used for more than two years after the license is granted. The report was adopted.

Accrington.—To the Accrington and Church Co-operative Society belongs the credit of laying the first installation of electric lighting in Accrington. The central stores of the society would in all probability have been lighted by electricity 12 months ago but the Board delayed matters in anticipation of an electric lighting plant being put down by the Corporation. This, however, did not come about and the society resolved upon providing its own current. The installation is for about 425 incandescent lights in the various shops and rooms, and in addition there are six arc lamps, two in the central grocery department and four in the drapery establishment. Willans-Crompton direct-coupled engines and dynamos are used and there is an Epstein accumulator. The contractors for the work are the Nelson Electrical Engineering Company, and the work has been carried out under the supervision of Messrs. J. McLellan and Co., of Blackburn, as consulting engineers.

Knutsford.—At the meeting of the Bucklow Rural District Council the clerk read a letter from Messrs. Brett, Hamilton, and Tarbolton, solicitors, Manchester, on behalf of the Carriage and Tramways Company, who propose to extend their system of tramways through Stretford, Sale, Tarporley, Altrincham, Dunham Bowdon, and Peel Causeway, and work them by electric or other mechanical traction; and it was resolved to ask the promoters to attend a meeting of the Council with plans. Mr. Sampson, solicitor, and Mr. Andrew attended the Council with reference to scheme of an electric tramway from Peel Causeway to Stockport, taking a route through Altrincham, Timperley, Sale, Stretford, Old Trafford, Moss Side, Withington, Longsight, Levenshulme, Heaton Norris, to Stockport. It was stated that the tramway would be worked in connection with the present system of electric lighting either by the same company or by arrangement for supplying power. Mr. Andrew explained the scheme, stating that it was simply an extension of the Manchester tramways to Peel Causeway, and nearly encircling the whole of Manchester and its suburbs.

Pekin.—According to the *Scientific American*, the "Pekin University," an educational institution conducted by the American Methodist Episcopal Mission, has recently opened in one of its buildings a museum which it is proposed to devote largely to the exhibition of foreign machinery and mechanical appliances. This museum is visited daily by increasing numbers of the people of the better classes, and the authorities would be glad to receive and exhibit models and drawings of electric or any other machinery. Each exhibit which may be presented to them will be marked in Chinese, with the name and address of the maker, together with the description and price, if desired, and a capable translator will explain their use to enquirers. Correspondence on this subject and articles for exhibition may be sent to the Pekin University, Pekin, China; or to Mr. Charles H. Taft, treasurer, 78, William-street, New York, U.S.A.; and under an arrangement with the Chinese Customs Department any exhibits will be imported into China free of duty.

Belfast.—At the meeting of the Electric Committee the assistant engineer, Mr. Olsson, attended, and reported on the application made on behalf of Messrs. W. and G. Baird for a reduced rate for

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a large supply of electric current for driving printing machines, and it was decided to recommend the Town Council to authorise a special scale for this and all similar cases of large daylight consumption. At the monthly meeting of the Corporation the Lighting Committee's report, which was adopted, contained the following: "Your committee have to report that the arbitration with Messrs. M'Comish and Shaw in regard to the light in their premises, which was obstructed by the buildings of the central station, resulted in an award of £48 to be paid by the Council. In order to encourage the daylight consumption of current, and to meet the requirements of the different industries likely to adopt electric motors for daylight use, your committee recommended that they be authorised to supply current at the specially reduced rate of 2¾d. per unit for all current used over 4,000 units. Your committee have to report that it is now necessary to provide the additional plant referred to in previous reports, and they are in treaty for the supply of one additional direct-driven engine and dynamo."

Leeds.—We mentioned last week that the Tramways Committee of the Leeds Corporation selected for consideration the names of five out of a total of 35 applicants for the position of clerk of the works in respect of the projected electric tramway from Roundhay Park to Kirkstall. The committee have now had all five applicants before them, and finally decided by a narrow majority to recommend the appointment of Mr. John Burbridge, the manager for the Thomson-Houston Company of the late electric tramway on Roundhay-road. The candidates were Mr. F. B. Lea, of London; Mr. Ernest K. Scott, of Wolverhampton; Mr. C. F. F. Smith, of Blackpool; and Mr. H. G. Sprague, of London. Each one was requested to mention the amount of salary he hoped to receive, and the sums named varied from £2. 5s. to £5. 15s. per week. Mr. Burbridge asked the sum of £3. 3s. An amount much in excess of this was asked by Mr. Ernest Scott, and his qualifications so impressed the committee that he nearly secured election. In selecting Mr. Burbridge the committee were influenced to a considerable extent by his experience on the old Roundhay electric tramway. The appointment was afterwards confirmed by the full Highways Committee, and will be submitted to the full Council for approval. The committee intend to push on with the new tramway as rapidly as possible.

Leith (Midlothian).—On the discussion in the Town Council of a motion "that the magistrates and Council resolve to apply to the Board of Trade for a provisional order authorising them to supply electricity for public and private purposes within the burgh," Bailie Manclark, who moved the resolution, said that the burgh would probably have been better off if they had gone in for electric lighting a year or two before, because those who had the power were now making the light for themselves, and the Corporation had thus lost their custom. Another reason was that they would not have had the taunt of Edinburgh offering as a reason for amalgamation that they would have the electric light. The committee had gone thoroughly into the matter, and he stated that the approximate cost would be £25,000. They anticipated that there would be considerable saving to the baths in having the electric light station near it. They estimated the annual expenditure on the working of the plant as £2,780, and the revenue as £6,850, leaving a probable balance of £4,070 if the whole plant was thoroughly occupied, and of £133. 10s. if only half the plant was put on. Moreover, electricity might be used for the tramcars. Councillor Craig seconded the resolution. He thought the people of Leith wanted the light. Councillor Baxter feared that they would never be able to produce the light as cheaply as in Edinburgh. Ultimately the motion was agreed to, and it was remitted to the Electric Lighting Committee to take all necessary steps and submit to the Council a draft of the proposed order.

Liverpool.—In the Town Council Mr. Richard Dart moved the recommendations of the Lighting Committee for reducing the price of current—namely: "That meter rents be reduced from 2s. to 1s. per month; that in the place of the present uniform charge for electrical energy of 7½d. per unit the following scale be adopted: for each unit up to 1,000 units per month, 7d. per unit; for each unit in excess of 1,000 units per month, 4d. per unit; that the charge for electrical energy for heating, cooking, or power (when supplied through a separate meter) be reduced from 5d. to 4d. per unit; that consumers occupying two or more places of business be allowed to have them included in the same account; that the above reductions come into force on October 1, and be subjected to the general conditions of supply and installation regulations of the Corporation electricity supply department." Mr. Dart explained that the committee wished to move slowly. In the cases of large consumers, however, they were making a great reduction, because it was obvious that these consumers might erect works for themselves, and they were entitled to have their work done cheaply. The committee were fully alive to the importance of pushing forward the lighting of the city. Mr. G. H. Ball asked whether the committee had calculated upon making sufficient profit to leave a margin upon the working of the undertaking, or were they going to act in a spirit of philanthropy. Mr. Dart replied that the committee would not feel themselves at liberty to reduce the charge beyond a paying point unless they distinctly informed the Council of the fact. Mr Rutherford said he had been informed on excellent authority that the electric light could be supplied much more cheaply—35 or 40 per cent. more cheaply—by the high-pressure system than by the low pressure method. It would also do away with the necessity for the numerous stations which were costing so much money. He wished to know whether the committee were taking any steps to ascertain the comparative cost of producing electricity. Mr. Dart said he learned from the electrical engineer that the cost of the electricity by the high-pressure system was not much smaller than by the other method. Moreover, the high-pressure system was most dangerous, and he should be loth to see it introduced into Liverpool. The recommendations were then confirmed.

Morley.—Public notice has been given by the Corporation of their having obtained from the Board of Trade an electric supply license, and a beginning of the work was made last week, when a gang of men were started laying pipes underneath the footpath in the main streets for the electric lighting cable. The scheme has been prepared by and is being carried out under the supervision of Mr. Robert Hammond, London. So far back as 1893 the Town Council began to seriously consider the question of electric lighting, and in August in that year the Electric Lighting Committee advertised for schemes for the electric lighting of the town hall and the borough generally, and offered a premium of £100 for the scheme which was considered most suitable. The result was that nine schemes were received, and, after consideration, that from Mr. R. Hammond was awarded the premium, which, however, is merged in the commission for carrying out the scheme. Mr. Hammond's scheme is an alternating-current one, and includes the lighting of Queen street, Chapel-hill, and Church-street, but the license includes the whole of the borough, and will prevent private individuals setting up works in rivalry with the Corporation. A site in Fountain-street, directly opposite the Great Northern goods station, has been acquired by the Corporation for the erection of the generating station. From the central station high tension mains will be laid down Albion-street and Queen street, with transformer sub-stations at intervals. This work will be done by contract, tenders for which have yet to be received, and the work which is now being carried out is simply the laying of the pipes for the mains. The Electric Lighting Committee are endeavouring to arrange for some lighting to begin this winter by means of a temporary engine, but it will probably be next summer before the whole of the permanent works are completed.

Worcester.—In the agenda for the next meeting of the Town Council is the consideration of a long report referring to the disputes as to the electrically-driven pumps. Last spring Mr. W. P. Hughes resigned the chairmanship of the Water and Sewerage Committee "because he had lost confidence in the city engineer, owing to his reports as to the saving to be effected by the use of electricity for pumping at the waterworks not being borne out by the result of such use." The matter was referred to the Deputy Mayor (Hon. A. P. Allsopp) by the joint sub-committees of the Water and Sewerage and the Electricity Committees, who suggested the following points as those upon which information should be sought: (1) What was the city engineer's authority for the following advice given to the Council in his report of February 16 1894, "I have considered the matter very carefully, and although an estimate of this kind must necessarily be somewhat uncertain; I am of opinion that the proposed arrangement should at a moderate estimate yield a return of £600 a year for the outlay in the saving of fuel, while the expenditure would also result in the extension of the electric lighting main through a district likely to provide customers for the light." (2) Has such advice been justified by the result, to any and to what extent? (3) If not justified, then why not? Mr. Allsopp heard the city engineer, the electrical engineer, and other witnesses at an enquiry held on June 17, and at a meeting of the Joint Sub-Committees on July 8 submitted the following report, which was ordered to be printed: "In reference to the enquiry which was held by me, acting under the authority of your resolution of June 1, 1896, I beg leave to inform you that the city engineer, in advising the Council in his report of February 16, 1894, to adopt electricity for pumping at the waterworks, based his advice upon the result of calculations which, considering that they were confirmed by the consulting electrical engineer, constituted, in my opinion, ample authority for such advice being tendered to the Council. As regards the question whether this advice was justified, everything turns upon the interpetation to be placed upon this word Adopting a strictly literal interpretation, I have no doubt that the city engineer has shown that the reasons which induced him to give such advice to the Council were both adequate and sufficient. On the other hand, if a more popular interpretation be adopted, there is no doubt (and the city engineer himself admits it) that that portion of his advice which relates to the electric pumping has not been justified to any extent by the result. After a careful consideration of the facts which the enquiry brought out I am of opinion that the special circumstances at the electricity works and during the year 1895 are a sufficient reason why the original forecast of the city engineer has not been completely fulfilled. The extension of the electric lighting main has enabled the Corporation to obtain a small revenue from the supply of current for lighting purposes."

PROVISIONAL PATENTS, 1896.

AUGUST 24.

18669. **Improvements in means for suspending the electric conductors used in electric railways, tramways, and the like, known as the trolley wire.** Magnus Volk, 36, Eaton-place, Brighton.

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18666. **Improvements in means for the construction of submerged or partially submerged permanent ways for cars driven by electricity, steam, or other motive power; also for steep grade permanent ways for cable cars and the like.** Benjamin William Clayton Botham, "Ravenswood," Stanford-avenue, Hassocks, Sussex.

18680. **Fixed-contact apparatus for use with railway electric brakes.** Hubert Georgin, 8, Rue des Princes, Brussels.

18704. **Improvements in connection with electric traction systems.** Herbert Allen and Oliver Peard, 55 Chancery-lane, London.

18711. **Appliance for preventing noise in wheel gearing of pumps, or any machine or machinery driven by electric or any other power.** William Wright, 8, Louvaine-road, New Wandsworth, London.

18730. **Improvements in or relating to alternate-current motors.** Valerè Alfred Fynn, 47, Lincoln's-inn-fields, London.

AUGUST 25.

18785. **Improvements in telephonic apparatus.** Carl Joseph Schwarze, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

18786. **An improved system of control for electric motors.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Elmer Ambrose Sperry, United States.) (Complete specification.)

18830. **Automatic electrical indication of the names of stations in each separate compartment of trains in motion.** Frederic James Longton, Rosemont, Woolton Hill, Lancs.

AUGUST 26.

18839. **An electrical system of railroad and fog signalling. To be used in conjunction with the present system of railroad signalling.** Henry Gilhespie, "Rosebank," Station-road, Chingford, Essex. (Complete specification.)

18841. **The abolition of the commutator in continuous-current dynamos and motors.** Sidney Augustus Nash, 206, High-road, Kilburn, London.

18843. **Improvements in electrical switches.** Herbert Grace Richardson, 70, Deansgate, Manchester.

18867. **Improved electric trolley mast.** Ernest Kilburn Scott, The Elms, Bushbury-lane, Wolverhampton.

18878. **Improvements in gas-valves actuated by means of electrical energy.** The Midland Purchase Syndicate, Limited, and William Henry Gritton, and Walter Whitington, 55, Chancery-lane, London.

18889. **Improvements in electric light switches.** Andreas Peter Lundburg, 18, Regina-road, London.

18892. **Improvements relating to switch fuses or electric safety fuses.** Charles James Hall and Henry James Fuller, 433, Strand, London. (Complete specification.)

18907. **An electric coin-freed apparatus for dispensing liquid refreshments.** Harold Imray, 28, Southampton-buildings, Chancery-lane, London. (Octave Valdobra, Belgium.)

18908. **An improved writing desk or slab, more particularly applicable as an adjunct to telephone receivers.** Frederick Charles Lehfeldt and James Stevens, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

18912. **Improvements in or relating to telephone systems.** Moise Freudenberg, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, August 7, 1896, being date of application in France.)

18914. **An electrical means by which an hostile fleet or army may be rendered powerless.** Richard Joseph Crowley and William Olney Baker, 59, Chancery-lane, London.

AUGUST 27.

18951. **Improvements in electrical accumulators.** Alfred Conder and Edouard Paul Michelot, 8, Great Portland-square, London.

18968. **Improvements in current-actuated bell buoys.** Albert Louis Woodworth, 322, High Holborn, London. (Complete specification.)

18974. **A new or improved apparatus for electrically smelting metals, and for other like purposes.** John Laskey Dobell, 57, Chancery-lane, London.

18987. **Improvements in regulators for electric arc lamps.** William Robert Lake, 45, Southampton-buildings, Chancery-lane, London. (Agostino Ferrario, Italy.)

AUGUST 28.

19021. **A new or improved incandescent electric lamp.** Jean Renous and Boleslas Bronislawski, 64, Mark lane, London.

19045. **Manufacture of secondary galvanic elements.** Albrecht Heil, 28, Southampton-buildings, Chancery-lane, London.

AUGUST 29.

19114. **Improvements in automatic switch devices for electric currents.** James Thornhill Ashton, 111, Hatton-garden, London.

19148. **Improvements relating to electric current transformers.** William Robert Lake, 45, Southampton-buildings, Chancery-lane, London. (The Elektrizitats-Aktiengesellschaft vormals Schuckert und Co., Germany.)

SPECIFICATIONS PUBLISHED.

1895.

13957. **Trolley systems of electric propulsion and in apparatus therefor.** New.

14627. **Electric fire alarms.** Brown and Neilson.

15024 **Electrolytic production of amalgams and their utilisation.** Andreoli and Andreoli.

15895. **Electric contact making and breaking apparatus.** Quincey and Collins.

16521. **Overhead system of electric traction.** Bersey.

17063. **Electric smelting.** Willson (Date applied for under International Convention, February 20, 1895.)

18305. **Means of supporting and insulating electric conductors within culverts or like conduits.** Crompton.

18588. **Fusible cut-out or safety devices for electric conductors.** Partridge and Berry.

18935. **Apparatus employed in regulating electromotive force in alternating-current circuits for theatre lighting or other useful purposes.** Probert and Moy.

19353. **Electric gas lighting apparatus.** Jahnsson.

1896.

6480. **Rail bond for use on electric railways and for like purposes.** Turner.

12344. **Method of indicating at a telephone station whether the telephone lines are engaged or not.** Naglo.

13046 **Cleats for electric and other wires and the like.** Evans.

13264. **Regulating induction electric motors.** The British Thomson Houston Company, Limited. (Armstrong.)

13723 **Incandescence electric lamps.** Germer and Hüller.

14442 **Telegraphy** Essick.

15031. **Dynamo-electric machines and methods of compounding the same.** The British Thomson-Houston Company, Limited. (Steinmetz.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5¼-5¾
Brush Company, Ordinary	3	1¼-1½
—— Non. Cum., 6 per cent. Pref.	2	1¾-2
—— 4½ per cent. Debenture Stock	100	110-113 x d
Central London Railway, Ordinary	10	10¼-10¾
——	2	4⅛-4⅜
Charing Cross and Strand	5	9¼-9¾
Chelsea Electricity Company	5	7¾-8¼
—— 4½ per cent. Debentures	100	114-117
City of London, Ordinary	10	16-17
—— 6 per cent. Cumulative Pref.	10	17½-18½
—— 5 per cent. Debenture Stock	100	132-126
City and South London Railway, Consolidated Ordinary	100	51-53
—— 4 per cent. Debenture Stock	100	136-138
—— 5 per cent. Pref. Shares	10	14½-15
County of London and Brush Provincial Co., Ordinary	10	8-9
—— 6 per cent. Cum. Pref.	10	13¾-14¼
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2¼
Edison and Swan United Ordinary	3	1¾-2¼
—— 4½ per cent. Debentures	100	103-106
Electric Construction, Limited	2	1⅛-1⅜ x d
—— 7 per cent. Cumulative Pref.	2	2¾-3¼ x d
Elmore's Copper Depositing	2	½-1
Elmore's Wire Company	2	⅜-⅝
W. T. Henley's Telegraph Works, Ordinary	10	18-19 x d
—— 7 per cent. Preference	10	18½-19½ x d
—— 4½ per cent. Debentures	100	110-115 x d
House-to-House Company, Ordinary	5	4-4½
—— 7 per cent. Preference	5	8¾-9¼
India Rubber and Gutta Percha Works	10	22-23
—— 4½ per cent. Debentures	100	107-110
Kensington and Knightsbridge Ordinary	5	9½-10
—— 6 per cent. Pref.	5	8-8½
Liverpool Electric Supply, Ordinary	5	8-8½
Liverpool Overhead Railway	10	13¼-13¾
—— 5 per cent. Pref.	10	17⅛-17⅝
—— 4 per cent. Mortgage Debentures of £100	100	112½-114½
London Electric Supply	5	⅞-1⅛
Metropolitan Electric Supply	10	13-14
—— 4½ per cent. First Mortgage Debenture Stock	100	120-123
National Telephone, Ordinary	5	7¼-7¾
—— 6 per cent. Cum. First Pref.	10	17-19
—— 6 per cent. Cum. Second Pref.	10	17-18
—— 5 per cent. Non. Cum. Third Pref.	5	6¾-7
—— 3½ per cent. Deb. Stock	100	107-110
Notting Hill Company	10	11½-12½
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8¼-8¾
—— £4½ shares	4½	7¼-7¾
Oriental Telephone and Electric Company	1	¾-⅞
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	105-107
Southampton Electric Company	5	4¾-5¼
St. James's and Pall Mall, Ordinary	5	12-13
—— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	40-43
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	—	8-8½
Westminster Electric Supply, Ordinary	5	11-12
Yorkshire House-to-House		7½-8

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NOTES.

Cable Extension.—The Dutch Government are proposing to lay a cable between Atjeh and Lombok, in the East Indies.

Obituary.—The death of Mr. R. W. Peregrine Birch, the civil engineer, is announced to have taken place at Foyers while he was on a visit to the works he was carrying out there for the British Aluminium Company.

Fatty Acids.—Mr. J. Hamonet has been studying the electrolysis of the mono-basic "fatty" acids, and from a communication to the Paris Académie des Sciences it appears that he finds that the results formulated by Kolbe are not always to be relied upon, and that non-saturated hydro-carbons may be produced instead of saturated ones. The matter has at present only a chemical interest.

Electro-Harmonic Society.—The concerts, which will be six in number, of the eleventh season of the Electro-Harmonic Society will be held on the last Fridays in September, October, November, January, February, and March. The committee, with a view to keep up the standard of musical excellence of these concerts, have decided to incur increased expenditure, but the members will be glad to know that their subscriptions will remain as before.

Prize Medals.—The programme of the prizes to be offered next year by the Société Industrielle of Mulhausen has been published in the *Revue de l'Electricité*. The society offers medals for the application of electricity to printing, for an installation of electric motors (this is confined to Alsace), for a motor capable of running at variable speeds, the extremes being in the ratio of 1 : 10 at least, for an improved method of attaching armature brushes, and, lastly, for papers on town and factory lighting.

Electric Fire Pumps.—Prof. Newcomb, in *Cassier's Magazine*, has a short article suggesting what he considers an ideal fire-extinction plant for mills. This consists of a pump, at a safe distance from the mill, capable of starting automatically and driven by a power independent of the mill, which in practice means driven electrically. A sprinkler system would be connected with a regulator, so that a fire would set to work some of the sprinklers under the influence of the heat, which would diminish the water pressure, this in turn acting on the regulator which starts the motor and the pump.

Motorcarts.—A gentleman who, though he signs himself "Rusticus," is obviously no countryman, or he would not talk about "Rosetti-land," has written to the *Daily News* to complain that a motorcart has gone down a lane. We have naturally no affection for the oil motorcart, but if no vehicle that could be heard or smelled—"Rusticus" talks about stench—were allowed in the country, agricultural operations would be restricted even in Arcadia. The manager of the Anglo-French Motorcar Company has been fined by the Epsom Bench for somewhat anticipating the coming into force of the Act.

Labour Troubles.—The threatened strike in the engineering and shipbuilding trade has fortunately been settled. The quarrel in the glass trade it appears is to be fought out, but this, compared with the other, is a very small affair. Lastly, the secretary of the Tailors' Improvement Association has appealed for help to a City company. The Master of the Merchant Taylors' Company replied that the powers of the company of forcible intervention in trade disputes "have not been exercised for many years." It may safely be said that few people know precisely what those powers are.

Another Submarine Boat.—According to the *Daily News*, a new submarine boat on Poukalov's system, whatever that may be, is approaching completion at Cronstadt, and will soon be put to its trials. The boat is to be driven by electricity, supplied by accumulators sufficient to last for a two hours' run, and is to have a speed of 10 knots an hour. Beyond the statement that the boat is adapted for travelling along the surface of the water and for submerging itself to a depth of not more than 7ft. by the aid of horizontal rudders, no further details are available.

London Telegrams.—It is well known that most of the telegrams sent from one part of Central London to another are not really telegraphed, but are blown or sucked through the pneumatic despatch tubes. The *St. James's Gazette* has suggested that this being so the Post Office should give up the farce of copying these messages off white paper on to pink as though they had been over the wires, and save time and labour and the opportunity of mistake by delivering them at once as they are written. The suggestion seems a sensible one, but that gives no guarantee that it will be speedily adopted. Something of the sort is, however, done in Paris.

Cost of German Education.—The British Consul-General at Frankfurt, in the course of a report, has referred to certain official information supplied to the Italian Government in regard to the cost of university study in Germany. From this it appears that at Berlin the cost of a civil engineer's course, including that of living, is estimated at 6,000 marks (say, £300) for four years. At other German universities the cost would be somewhat less, but the difference would not be very great, for the main item—the cost of living—is very much the same in all university towns. Foreign students often prefer the smaller universities, especially those in South Germany.

Physicians of the Future.—Last week's issue of the *Lancet* (September 5) is entirely devoted to the needs of these. It embodies the courses and calendars of the colleges and hospitals, with references to science colleges and other institutions as to which information may be of value to medical studends. It may be noticed that the name of Faraday House appears, but not the City and Guilds Institute. The position of the qualified English medical man who desires to practice abroad is also treated of, and this article is interesting, as showing the different spirit in which the subject is dealt with in different countries, whether with a view to the protection of the public or of the local medical profession. Germany, as usual in scientific matters, sets a good example. There, apparently, you may do as you like about having a German doctor or one of your own nationality, only the latter must not stick any letters after his name which would make people think he had a German qualification. That is rigidly suppressed, and with reason. Austria, on the other hand, requires a 10 years' residence and naturalisation, and France does not make things too easy. In general the Colonies are contented with a registration fee.

Submarine Boats.—The *Bulletin* of the French Society of Civil Engineers contains Mr. G. L. Pesce's paper on submarine navigation. Mr. Pesce goes to the form of deep-sea fishes to obtain the proper shape for a submarine boat, and in his history of the subject starts from the time of Demetrius Poliorcetes. We may, however, begin by skipping 21 centuries, more or less, and start fair with the year 1796. It appears that since that date about 60 designs for submarine vessels have been brought out, and most of them have got as far as actual construction, so that on an average the submarine boat is invented twice

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in every three years. It is needless to say that since the discovery of the storage battery electricity is usually chosen as the motive power. Mr. Pesce does not claim to have given a complete list, and the boats are practically in all cases designed as instruments of warfare. Nevertheless, the author concludes his paper with the remark that he has a profound conviction that the question of submarine navigation will in the very near future be settled from a commercial rather than a warlike point of view, to the great profit of civilisation and universal peace. How the latter is to be promoted by fighting under water instead of on the surface is not altogether clear.

Cost of Arc Lighting.—A preliminary report of the National Electric Light Association on arc lighting statistics, embracing about 400 cities and towns of the United States, having a population of 5,000 or more, has been issued, and is summarised in the *Electrical World*. The report gives for each town the number of arcs, candle-power of each, price per night, and the time of burning. There appears to be a wide variation in the cost of street lighting, one municipal plant reporting a cost of 36dol. per year for 1,200-c.p. lamps burning seven hours per night "under a moonlight schedule," while the price paid in one of the largest cities is 182·50dol. per year for the same candle-power arcs burning all night. The report shows that the rates in four municipalities are above 180dol. per annum, while in one municipality above 170dol., in five above 160dol., in six above 150dol., in nine above 140dol., in 10 above 130dol., in 31 above 120dol., in 28 above 110dol., in 58 above 100dol., in 73 above 90dol., in 61 above 80dol., in 64 above 70dol., in 34 above 60dol., in 14 above 50dol., and in nine above 40dol. Of the 33 municipal plants mentioned, 10 failed to report, and of the remaining 23 which reported, the cost for nine ranges from 50dol. for 1,500-c.p. arcs to 96dol. for 2,000-c.p. arcs, burning all night, and for the remaining 14 from 36dol. for 1,200-c.p. arcs to 70dol. for 2,000-c.p. arcs burning on a moonlight schedule.

Cornell University. — We have received from Ithaca, New York, the programme of the instruction in physics at Cornell University. The experimental and laboratory work seems very full. Beginning with elementary mechanics and electrostatics, the student in the first year gets as far as batteries. The second year is devoted to continuous currents and the third to alternating currents and photometry. There appears, however, to be no reference to polyphase-current work. Work in applied electricity is carried on in a building arranged for the purpose. On the lower floor is the dynamo laboratory of the department, a room 35ft. by 100ft. It contains two main lines of shafting, extending the entire length of the room and each driven by an electric motor of 50 h.p. More than 40 dynamos and motors of various types and sizes are in constant use for experimental purposes, and there are available also large batteries of accumulator cells (about 150 cells). Alternating currents of various potentials are obtained, by means of specially constructed transformers, directly from the lines of the public supply company. The upper floor of this building contains laboratories for electric light photometry and for various studies in electro-technics. In the post-graduate courses ample provision is made for the teaching of the higher mathematics, including some of the modern methods, which are still, as it were, admitted under protest and only to advanced students on this side of the water.

Electrolysis in Sugar-Making.—Among the matters dealt with at the Paris International Congress of Applied Chemistry was the application of electrolytic methods to the purification of sugar solutions in the course of manufacture. According to the *Journal des Fabricants de Sucre*, Mr. L. Battut, of the Arleux Works, started the discussion with a *résumé* of the various methods adopted. His conclusion was that for purification work electrolysis was a feeble method to depend upon, and was practically useless, except for decoloration. In conjunction, however, with dialysis it might be useful. His experience was principally derived from laboratory work. On the other hand, Mr. Baudry said that in actual practical work in the production of beet sugars in Russia, simple electrolytic processes had proved most valuable. The current was applied after the addition of lime in the usual way and defecation. Messrs. Aulard and Battut objected to Mr. Baudry's theory of the process, which was that the current broke up the non-saccharine constituents of the solution. Prof. E. Peyrusson, of Limoges, raised what seems a reasonable protest against the use of lead anodes. (Lead would be a most convenient metal to use in sugar manufacture in another way if it were not for the danger of lead-poisoning from traces remaining unremoved in the finished product.) Mr. F. Dupont (the secretary of the congress), however, did not join in this fear. If the purification process was not pushed too far, there would be no danger of the lead going into solution. He was not, however, prepared to say that the electrolytic process was as yet a practical one, but he did not despair of it becoming so.

Gas and Electricity.—Mr. D. M. Dunning has an article in the *Engineering Magazine* on the subject of "Gas *v.* Electricity direct from Coal." The latter part of the title refers to the Jacques cell, in which he sees no cause for fear on the part of the gas interest. In this we quite agree with him, though not for the same reasons. Mr. Dunning's general conclusions on the position of the gas industry in America in the face of electrical competition are more interesting. He admits at once "that the day has certainly gone by when the gas manager can sit quietly around and allow his works and business to run him. He must now reverse things—run the works and push the business; and so thoroughly has this become recognised that the industry, where properly managed, has already become one of the most prosperous in the land. It has held its own through the shrinkage of values and financial reverses of the past few years better than almost any other, and, where it has kept clear from electrical entanglements, has paid its dividends with surprising regularity. In the way of the utilisation of residuals and illumination through incandescent lamps, it has, through the aid of science, made most rapid advances, and still presents, in these and other lines, the broadest fields for scientific research and investigation. At various times it has, in the minds of many, been threatened with serious, if not fatal, competition from electricity; yet the gas industry is probably to-day in a healthier and more prosperous condition than it would have been if electricity had never been a competitor, because the electric light has created a demand for more light and a stronger light, which, together with its competition, has stimulated the gas industry to improvement, and to advance and extend its business; and on these lines, and with the aid of lower prices, the future manager seems to have an almost unlimited field."

British Association (General).—The secret of the president's address is well kept, but more "forecasts" have been published as to what is to take place in the sections. Biology in general we pass by, but in the Zoological Section we are to have the age of the earth again. For many years there has been a standing quarrel between the physicists and the geologists on this subject. The former have a strong case, but have on the whole

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been unlucky. Very early in the dispute Lord Kelvin made a curious misinterpretation of the meaning of one of his mathematical results, and when Mr. George Darwin tried to arbitrate the question in favour of the heat-people with the help of the moon his work was popularised in such a manner that the average geologist might easily believe it to be as incapable of supplying an accurate time gauge as his own inexact science. The result of it all is that, instead of the modest 200 millions of years—that is all that physical investigation seems to allow him—he has gone on asking for millions of millions of years, and now we have Prof. Poulton asking on behalf of the zoologists for a still further extension, in order to account for what must have occurred previous to the history which we find in the fossiliferous strata. But things might have gone a bit quicker in those days. At the meeting of the Douglas Town Council the Mayor (Major Stephens) said that he had consulted Dr. Gill and others representing the Antiquarian Society as to giving a conversazione on the occasion of the visit of the members of the British Association to the Isle of Man on the 26th inst. The Mayor undertook, with the consent of the Council, to defray the expenses of the conversazione, which he proposed to hold in the School of Art. He said about 200 members were expected from Liverpool. Lord Henniker (the governor of the island) had promised to attend, and probably the Earl of Derby would be present. The Council unanimously passed a resolution endorsing the Mayor's action, and promising their support.

A Suffolk Suggestion.—Bury St. Edmunds is not in all respects like other towns of the same size in the way things are done there, and the existing distinction is apparently to be preserved in the matter of electric lighting. Not content with having a scheme that reverses the ordinary proportion of the areas of private and public incandescent lighting, the Town Council have elaborated a proposal in connection with the financial portion of the work that is so entirely novel that it appears to have been entirely misunderstood by everyone outside the borough. Certain ratepayers threatened to oppose the scheme for fear it might increase the rates, whereupon the members of the Electric Lighting Committee proposed to form a private company—not to do the electric lighting, but to indemnify the borough if the enterprise proved financially a failure, and to take all the profit if it proved a success. The town was to find the money, do the work, and apparently manage the business, but the gain or loss was to go to the company. The town clerk, on being appealed to for his opinion on this way of doing things, declined to give one without consideration. As he had had his advice on a much simpler matter overruled, we think he was wise. But he referred the matter to his parliamentary agent, Mr. E. E. Baker. That gentleman "had never heard of such a proposal," and thought "the scheme would be quite unworkable unless the Corporation had an absolutely free hand as to the price to be charged for lighting." Obviously, if the Council fixed the price low enough, there would be no profit, and a loss would not matter, since the company would have to indemnify it. Mr. Baker's advice on the subject substantially amounted to telling the Town Council, if they determined to persist with their proposal, to "try it on" first with the Board of Trade by inserting special clauses in their electric lighting order. Having got the consent of the Board of Trade, the Local Government Board might possibly be induced to pass the necessary loan. We should be inclined to doubt it, although the gain is all on the side of the Corporation. Municipal and Government guarantees are common enough abroad, and we have got as far as admitting the principle here in connection with light railways, but a private company guaranteeing a municipality is somewhat of a reversal of the usual order of things.

An American on Labour. — Under the title of "Modern Machine Shop Economics," Mr. H. L. Arnold, who once was a journeyman machinist, contributes an article to the *Engineering Magazine* on the subject of first principles in the management of men. It is practically a plea for piecework, with, as we understand it, an additional premium on the number of pieces turned out. It is not very clear how the workman is made to understand that what he fears will not come about—namely, that when a piece price has produced a greater output and earning, it may be cut down—but this is implied somehow or other. Mr. Arnold, however, treats trade union and class feeling generally in a way to make a labour leader's hair stand on end. For instance, he says: "The typical wage-earner is, first of all, incapable of managing any business, even his own, much more that of an assemblage of his fellows. Many large employers have, indeed, come out of the workshop, but they came out early in life; they never were union or trade society men." This, however, is not confined to "working men," but is an all-round business. Mr. Arnold, for instance, says, "Work for wages merely is vile, and vilely degrades the worker." As wages here must obviously include salaries, stipends, "retainers," or what not—in fact, any remuneration fixed in amount and paid every week, month, quarter, or year—it would seem that there must necessarily be a great deal of vileness and degradation in many branches of the commercial and professional world, while the prospects of the gentlemanly "services" are perfectly hopeless. Unfortunately for the adoption of Mr. Arnold's plan, all masters are not, any more than all workmen, either angels or philosophers, and competition tends to level the best down to the standard of the worst, or, at any rate, is believed to do so, which in practice comes to the same thing. The article, however, if it somewhat ignores the other side of the question, is not without a basis of sound sense, and whether the views expressed were right or wrong, it would all the same be worth notice from the vigorous way in which they are enunciated. Moreover, Mr. Arnold does not, like many people, draw arbitrary lines as to how far his principles should be carried out. Though he obviously hates the idea, he is, for instance, quite prepared to see women at work in the machine shops.

High-Frequency Currents.—The following is from an article by Mr. J. Tuma, in *Beiblätter*, on the subject of measurements with alternating currents of high frequency, which has been published as an abstract in the *Journal* of the Institution of Electrical Engineers: "The author gives a method whereby measurements of resistance can be made with oscillating currents. When a rapidly alternating current flows through a conductor of very small cross-section, it may be assumed that the current-density is uniform over the whole cross-section. If the heat generated—which in this case is due to the oscillating current—be measured, and also that generated by the passage of a continuous current through the same conductor, the amount of heat generated in each case, in equal times, will be in the proportion of the mean squares of the current-strengths. A conductor of very small cross-section can also be used for the measurement of the intensity of oscillatory discharges. If a thick wire, B, be put in series with the wire, A, of small cross-section, the relation between the amounts of heat generated in the two wires when continuous currents of different strengths are passed through them, remains constant; this, however, will, generally speaking, not be the case when oscillating currents are passed through the

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wires. If W be the heat generated in the wire B, and W_1 that generated in the wire A when the wires are in series with one another, and a continuous current of intensity J is flowing through them for a time *t*, and W' and W_1' the corresponding quantities of heat generated by the application of an alternating current of intensity J' during a time *t'*; moreover, let w_1 be the resistance of the wire A_1, *w* the resistance of the wire B for the continuous current, and *w'* that for alternate currents: then we have

$$\frac{w'}{w} = \frac{W'}{W_1'} \cdot \frac{W_1}{W}, \text{ and } J' = J\sqrt{\frac{W_1' t}{W_1 t'}}.$$

If a Bunsen ice calorimeter be used, and l, l_1, l', and l_1' be the corresponding distances through which the meniscus in the capillary tube of the calorimeter is moved, then

$$\frac{w'}{w} = \frac{l'}{l_1'} \cdot \frac{l_1}{l}, \text{ and } J' = J\sqrt{\frac{l_1' t}{l_1 t'}}.$$

From the combined results it is deduced that the ratio $\frac{w'}{w}$ increases with increased thickness of the conductor, and with the frequency of the current. From measurements on German-silver wires it was found that the ratio $\frac{w'}{w}$ approached nearer to unity as the specific resistance increased. That the resistance was dependent on the current strength was very noticeable, especially in a 2mm. and a 3·1mm. thick iron wire."

Local Government Board Enquiries.—The *East Anglian Daily Times* apparently objects to too much evidence being taken at a Local Government Board enquiry. Referring to the application of the Colchester Town Council for leave to borrow money for electric lighting, it is remarked that "there seems nothing to prevent the opponents of a particular scheme from arguing against it a second time when the inspector holds an enquiry, as if the town were governed, not by the Corporation, but by the Local Government Board." This, it is contended, ought not be possible. But the object of the enquiry is surely to prevent future ratepayers, who are as yet not in existence and cannot be heard, being burdened with an expenditure which they would never have consented to. Obviously that is a task which can only be performed approximately, and it does not appear how it could be performed at all unless the Board was willing to take all the evidence it can get as to whether the scheme is a good or a bad one. The case of one of the opponents, a farmer, deserves more sympathy than is usually accorded it. The nominal boundaries of some East Anglian boroughs stretch out far into the country, and include villages which derive no benefit from the town improvements they have to pay for. It is no doubt small comfort to Mr. Blyth to know that because Colchester was reckoned a half-hundred in the days of Athelstan, and that in those days it was worth paying to the borough scat to get the protection of the old Roman walls when the Wikings were abroad, his land must now take its share of the cost of municipal improvements, including electric lighting. He will be better pleased to learn that the Colchester scheme looks about as moderate and reasonable a one as could well be, and so far as is possible to judge in those matters is not likely to increase his rates, and may possibly diminish them. At Mitchelstown, in Ireland, the case of Mrs. Ellen Coghlan's cows, which "do not require the electric light to graze by," can be met by varying the area of taxation, but this does not appear to be possible in England. The Colchester enquiry also produced a gentleman who had "seen electric lighting worked successfully in the centre of Africa," and whose idea of success seems to be 2½d. per unit. This must be looked to. Up to the present the only information we have been able to obtain as to electric installations in the centre of Africa has been derived from the *Bier Zeitung*, published under the auspices of the Verband Deutscher Elektrotechniker.

Village Lighting.—The difficulties of a very small gasworks are not inconsiderable—that is to say, if a good quality of gas is to be supplied at a reasonable rate. On the other hand, though it has been contended that a small electric light installation need not in the nature of things be worked only at excessive cost, very little has been done practically in the way of supplying the needs of the large villages and small growing towns that have not already been taken up by the gas companies. In spite of the obvious advantage of having a free field, instead of endeavouring to turn out a company already installed in the streets and houses, and in possession of the sympathies of the local shareholders, it has apparently been thought that in the large village the game is not worth the incandescent lamp, and such places have in general been left to make their choice between the in every way troublesome and unsatisfactory petroleum lamp and unrelieved darkness. There are, of course, exceptions. For instance, some time ago we noted in this journal the introduction of the electric light into Mevagissey, where the population of the whole parish only a little exceeds 2,000. The progress of the company founded by Messrs. Veale, of St. Austell, to try how electric lighting will answer the needs of a fishing village on the South Cornwall coast will therefore be watched with interest. The place had been without public lighting of any kind. The generating station consists of a shed, containing a Paxman semi-portable engine, a Crompton dynamo, and a set of accumulators, while a few 16-candle incandescent lamps on wall brackets constitute the public lighting. Sufficient private business has already been secured to give full employment to the present engine power during the winter. The supply is by meter, at 6d. per unit, so that the village enjoys a cheaper service than the City of London. Whether or not the undertaking will pay dividends, of course, is yet to be seen, but the whole affair is an example of strictly economical electrical engineering, and the working appears to have given satisfaction. All the proposals made—and there have been more than one—for setting up a gas undertaking in Mevagissey have come to nothing; so that the little electric light company has undertaken a work which, as the *Journal of Gas Lighting* confesses, the most venturesome of contracting gas engineers have either overlooked or shrunk from.

British Association (Section A).—At the British Association it is the proceedings of Section A that primarily concern our readers. The following gives practically a programme of what is to be done in that section, though of course there will be some additional papers besides these enumerated. The section will meet daily at ten o'clock, and the committee meetings are at two. The reports of committees are nine in number, and deal with: (1) Electrical Standards (special report on a thermal unit); (2) Magnetic Standards; (3) Comparison and Reduction of Magnetic Observations; (4) the Establishment of a National Physical Laboratory; (5) Meteorological Observations on Ben Nevis; (6) Seismological Observations; (7) Calculation of the $G_{(r,\,\nu)}$ Integrals; (8) Mathematical Tables; (9) Solar Radiation. Among the papers we have first a group dealing with the kinetic theory of gases, on which there has been some very considerable criticism recently on the Continent. The first of these is by Lord Kelvin on "The Molecular Dynamics of Hydrogen Gas, Oxygen Gas, Vapour of Water, Water and Ice." Mr. G. H. Bryan entitles his paper "Some Difficulties Connected

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with the Kinetic Theory of Gases"; and Mr. S. H. Barbary's is "Stationary Motion of a System of Equal Elastic Spheres." The purely electrical papers include one on "The Division of an Alternating Current in Parallel Circuits with Mutual Induction," by Mr. F. Bedell, and others will be read by Mr. W. M. Mordey "On an Instrument for Measuring Magnetic Permeability"; by Mr. E. H. Griffiths on "The Measurement of Electrical Resistance"; and by Mr. W. H. Preece "On Disturbances in Submarine Cables." There will be also two others, of which the joint authors are Lord Kelvin and Mr. Magnus Maclean, which will deal with "The Communication of Electricity from Electrified Steam to Air," and "The Measurements of Electric Currents through Air at different Densities, down to the five-millionth of the Density of Ordinary Air." There is also a paper on "A Complete Apparatus for the Study of the Properties of Electric Waves," by Mr. J. Chunder Bose. It can hardly therefore be said that electricity does not have its fair share in the work of the section. The other papers are by Mr. S. A. Sworn, on "Researches in Absolute Mercurial Thermometry"; by Mr. W. E. Plummer, on a "Comparison of the Results obtained from the Records of Certain Anemometers"; by Mr. G. H. Bryan on the "Sailing Flight of Birds"; and pure mathematics is represented by a paper by Lieutenant-Colonel Cunningham, R.E., on "Connection of Quadratic Forms." There will be various papers on the Röntgen radiations, as to which particulars are not at present obtainable, and the whole of Friday is to be given to this subject. It is to be hoped, therefore, that the proper theory will be finally settled, though, of course, there should not now be very much doubt on the matter. These are the only papers on light, and it appears as though there would be none at all on acoustics. Perhaps that subject is considered to be exhausted for the present.

Scientific Education.—During the last week quite a quantity of important people have had something to say in the columns of the *Times* on the subject of scientific education in general and the production of competent chemists in particular. Sir Philip Magnus would spare the secondary technical schools. His remedy is to reorganise the London University. The primary need in organisation is the concentration of the teaching power of any one faculty in one institution. "Such organisation of the higher teaching, in the chemical faculty especially, is indispensable if English manufacturers are to be supplied with competent English chemists." Mr. R. J. Friswell says the average pay of the chemists in the great German aniline colour factories largely exceeds anything of the kind paid in England. "The German willingly pays and waits for results, often for years. The Englishman expects immediate results or the departure of the unfortunate chemist. But the great point is that, as Carnot organised victory, so the Germans have organised industrial research. With armies of chemists ranging from 100 downwards, they are able to place a force of thoroughly equipped men in properly furnished laboratories to follow up any line of research likely to yield results." The next voice comes from Oxford, of all places in the world. It is that of Mr. J. E. Marsh, who says scientific education in this country is in a bad state, not so much that it is inferior in method, but rather because it is considered inferior to classical and mathematical education. "Until our public schools and colleges recognise that science is to take its place in their curriculum on an equal footing with other subjects we cannot expect our manufacturers, saturated at school with Greek and Latin, to recognise the value of scientific research." This is a true witness. A controversy of this character would not be complete without Prof. Silvanus Thompson. On the subject of the frittering away of funds upon a host of inferior schools, Prof. Thompson says: "It is ridiculous to suppose that a smattering of chemistry given to 10,000 boys in 500 different centres can have any appreciable effect in the chemical industries as compared with that which might be effected by spending the same money on thoroughly training 100 young men in five highly-equipped modern laboratories. The absorption by Germany of our chemical industries is being effected, not by giving evening instruction to boys, not by science-teaching in courses lasting two years, but by giving men a first-rate laboratory education, lasting four, five, six, or even seven years, under the most eminent chemists of the day. These are the skilled tools whom the German manufacturer finds ready to hand and employs to develop his processes of manufacture." Of Prof. Thompson's 100 young men, perhaps 80 would make no valuable discoveries. The only way to find your true researcher is to set him researching. It is essentially an article not producible by education alone. The conclusion of Prof. Thompson's letter is important. The best teaching will not save our trade if it comes too late. "There is no question that in the future electricity will enter largely into the chemical manufactures. Already the electric refining of copper has practically superseded the older metallurgical processes, and for the manufacture of bleaching liquid, of chlorate of potash, of aluminium, of caustic soda, the use of electricity is extending every day. Under these circumstances one would have supposed that every first-rate technical college would have anticipated the coming time by establishing special electro-chemical laboratories and by appointing a special instructor in electro-chemistry. What are the facts? In Germany three at least of the universities have already created professorships of electro-chemistry, and large electro-chemical laboratories have been erected at three of the universities besides that previously existing at Frankfurt. In England, so far as I am aware, there exist only two small electro-chemical laboratories—one at the Technical College, Finsbury, one at the Municipal Technical School at Birmingham—and both of these are devoted to instruction in electroplating and typing rather than to research in electro-chemistry. As for the rest of the science colleges in England, they are too busy with preparing pupils to pass examinations or are too poor to be able to undertake any such new departure." The last lines go to the root of the matter. The original "Chemical Manufacturer" has another letter. We learn from it that he comes from Manchester, and employs "several research chemists." His anonymity is therefore getting much thinner. Lastly, Prof. Tilden has something to say, but as he takes a column and a half of the *Times* to do it, we regret that we cannot get it all into this note. Briefly, he agrees with Mr. Marsh. If the nation chooses to endow, and honour and admire "the elegant imbecility of classical learning" in comparison with science, science will naturally suffer. "In Germany the university professor is a great man, well paid, received at Court, and honoured by all classes of the community, and this because he is an eminent man of science. In England a few chairs are pretty well paid, the majority very badly, and the public regard professors generally as unpractical dealers in useless wares." The general ignorance of our manufacturers is astonishing, and the current remedy of "technical instruction administered in moderate doses to the workpeople," and certain speeches at the London County Council, are beyond his patience—as well they may be. That is all for the present. What more the fates have in store for us next week time will show.

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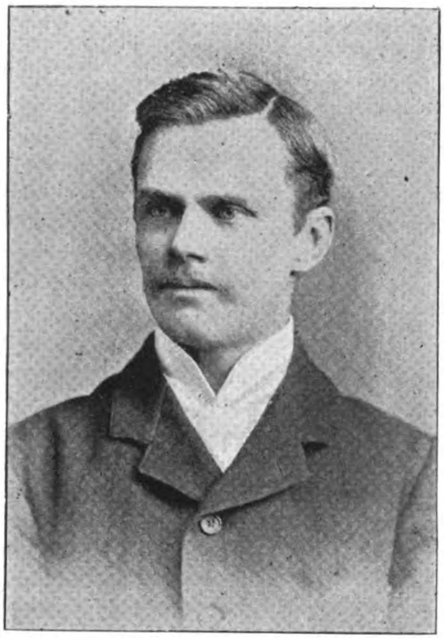
SOUTH SHIELDS ELECTRICITY WORKS.

(Continued from page 263.)

We are able, through the courtesy of the borough engineer, to give the accompanying view of the engine-room (Fig. 7). The day-load engine, with the alternator at one end and the spare exciter at the other, is shown in the foreground, while the large units are at the back. From



MR. JOSEPH A. JECKELL, A.I E E., BOROUGH ELECTRICAL ENGINEER.

this a good idea of the details of the engines can be obtained. It will be noticed that the engine-room staff have a high opinion of their personal beauty, and prefer front seats when photographs are being taken.

DISTRIBUTING SYSTEM.

As mentioned in our last issue, the distribution is carried out on the high-tension system, with transformer substations. The whole of the cables were supplied and laid by the India Rubber, Gutta Percha, and Telegraph Works Company, Limited, of Silvertown. The high-tension main (see Fig. 1) is designed as a ring, which can be divided at five points. These points are in the transformer boxes. The cable used is $^{19}/_{16}$ concentric, with rubber insulation, except in the case of Ocean-road, where $^{19}/_{18}$ cable is used. The cables are drawn into 3in. cast-iron pipes.

The low-tension mains are single-rubber mains of ·1 square inch and ·15 square inch sectional area. These are laid in 2½in. cast-iron pipes. When it is desired to connect house services, the cast-iron pipe is cut and a joint-box (Fig. 8) bolted on to the pipes, in which a mechanical joint is made. The joint-box is then run up solid with compound. This system is a patent of Mr. Jeckell's, and it is claimed that it combines all the advantages of laying cables in cast-iron pipes and armoured cables in the ground.

In case the cable fails and has to be taken up, it can be withdrawn between two house services without disturbing the street. Again, the joint can be as easily made in this system as in the case of the armoured cable laid direct in the ground, as it takes no longer to cut the cast-iron pipe and bolt the joint-box on than it does to cut armour off the armoured cable. Any kind of cable can be used with this box, either concentric or single. Samples of these joints have been submitted to a pressure of 2,500 volts, so that there is no fear of a joint failing at the low-tension pressure of 110 volts. The cables which supply the current to the arc lamps are single rubber-covered cables, $^{7}/_{14}$, and are drawn into the same pipes as contain the high-tension concentric cable. Fig. 9 shows the drawing-in box on the high-tension side. The cables are in all cases insulated with pure and vulcanised indiarubber, and the high-tension cables, in addition to the ordinary conductivity and insulation tests, had to be subjected to a high-pressure test at 5,000 volts both before leaving the works and after they were laid and connected up. The tightness of the system of pipes was tested by an air pressure of about 10lb.

The ring main will in general practice be divided with one and supplied from the two feeder panels of the switchboard. We are rather surprised to see that Mr. Jeckell has used two single cables in iron pipes for the low-tension side, where an induction drop is most to be feared.

TRANSFORMERS.

The transformers were supplied by Messrs. Ferranti and Co., and are of the automatic type. They are placed in boxes sunk in the street, and these boxes are in every case sufficiently large to hold a 30-kilowatt transformer

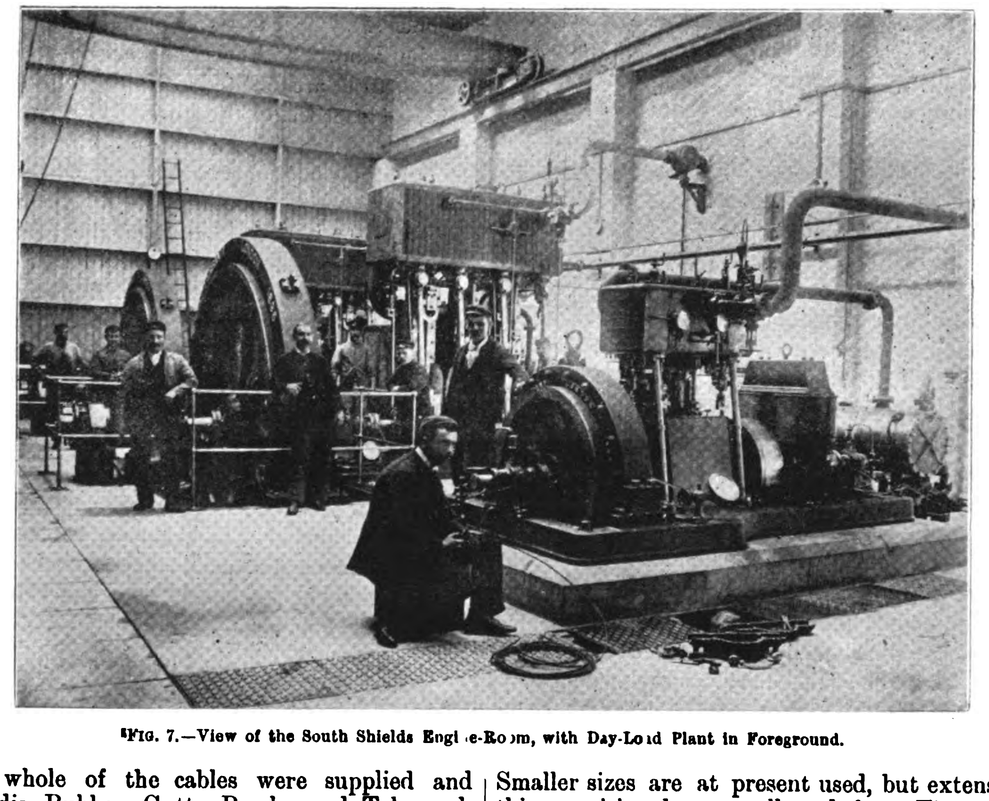


FIG. 7.—View of the South Shields Engine-Room, with Day-Load Plant in Foreground.

Smaller sizes are at present used, but extension can with this provision be easy allowed for. The system of automatic transformers is based on the patent issued some years ago to Mr. Ferranti. The primary and secondary winding are both subdivided, so that the sections normally in parallel can be put in series at times of light load. In

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this way the iron loss is reduced very considerably, and the lightly loaded periods of the day are not so expensive in coal consumption. The transforming ratio of these transformers is 2,000 volts to 100.

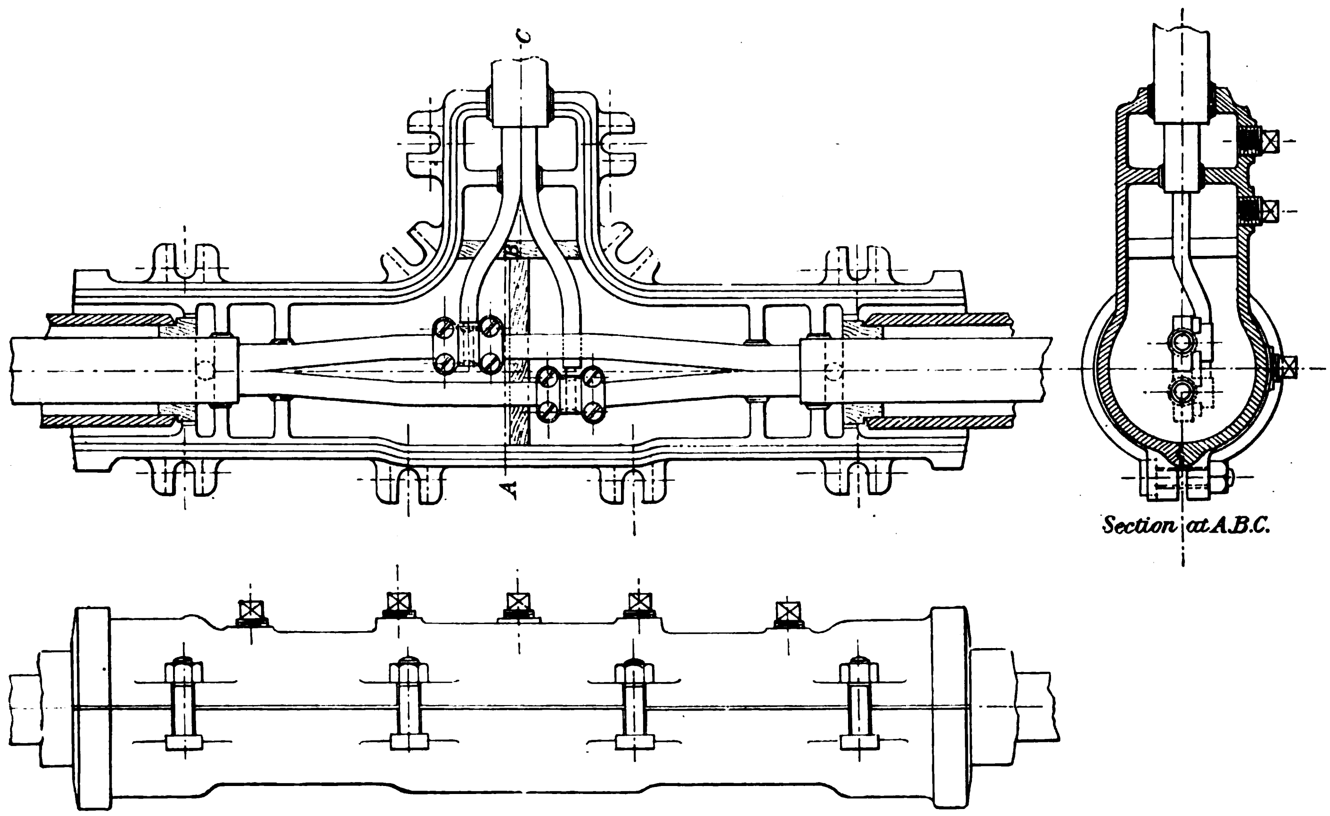

FIG. 8.—Low-Tension House Connection Box.

As mentioned in our last issue, the borrowing powers authorised at South Shields extend to a sum of £28,000, and up to the present only some £20,000 have been spent. Thus the committee have a good sum in hand for extensions, and will be able to foster the demand in likely districts by facilities for connections beyond the present network.

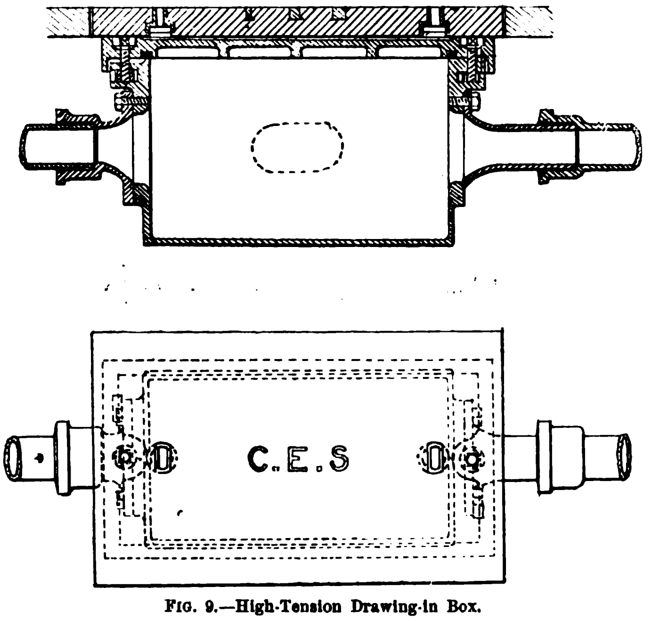

FIG. 9.—High-Tension Drawing-in Box.

The following list of contract sums shows approximately how the money has been spent:

Black, Hawthorn, and Co., boilers and pipes	£1,809 0 0
H. Watson and Sons, feed and condensing pumps ...	905 14 3
S. Z. de Ferranti and Co., engines, alternators, and switchboards	3,003 0 0
India Rubber, Gutta Percha, and Telegraph Works Company, cables and street work	4,846 0 0
S. Z. de Ferranti and Co., arc lighting plant	793 11 0
W. H. Brown, building	3,124 15 0

SCALE OF CHARGES.

The committee at South Shields have decided, under advice from their engineer, to fix the price per unit at 6d. for lighting purposes. A rebate will, however, be given to regular consumers. We gather from the interesting pamphlet that Mr. Jeckell has issued that maximum demand indicators will be used. After a consumer has burnt his maximum demand on an average for two hours per day, he will obtain all the rest of the electricity he requires at half-price—*i.e.*, at 3d. per unit. In order to give every facility to consumers desirous of using motors, the Corporation have also decided to charge the very low price of 2d. per unit for current supplied to motors.

THE PRINCIPLES OF ALTERNATE-CURRENT WORKING.*

BY ALFRED HAY, B.Sc.(EDIN.), A.I.E.E.

(Continued from page 270.)

56. In the preceding articles, we have made no special assumption regarding the shape of the E.M.F. or current wave when discussing the measurement of these quantities. We shall now investigate some special relations which hold for simple sine waves.

We shall in the first place consider the *mean* value of a simple sine function. Since every sine function is capable of being exhibited as the product of a certain constant quantity (the *amplitude* of the sine function, Art. 14) into the sine of an angle which varies at a constant rate with the time, it will be sufficient to determine the mean value of the sine. From this the mean value of the function may be obtained by multiplying by the amplitude (which is the *maximum* value of the function).

Let, in Fig. 47, O P be a line of constant length which, starting from the initial position O A, revolves round O with constant angular velocity. The mean value of the sine of the variable angle A O P over a half-period is obviously the same as its mean value over a quarter-period. Taking, then, the arc A B, which corresponds to a quarter-period, we divide it into a large number n of very small equal parts. If O P $= r$, then the length of the arc A B is $\frac{1}{2}\pi r$, and the length of each division is $\frac{1}{2n}\pi r$. In order to obtain the *mean* value of the sine, we determine its value at the

* Based on a series of evening lectures delivered at the University College, Liverpool.

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middle point of each division, add the values so obtained, and divide the sum by the number of divisions.

Let C D be one of the divisions, P its middle point. Then $CD = \frac{\pi r}{2n}$. Also, since C D is very small (although in the diagram, for the sake of clearness, it is shown fairly large), we may suppose that it is a short straight line. From C, P, and D respectively draw three straight lines at right angles to O A, and from C draw C E parallel to O A. Then, on account of the similarity of the triangles P_1OP, and E D C, we have

$$\sin P_1OP = \frac{PP_1}{PO} = \frac{CE}{CD} = \frac{C_1D_1}{CD}.$$

The same relation will hold for any other division. If we now take the sum of all the sines so obtained, it is evident that, on account of the length C D being the same for each division, this length will be a common denominator for all the fractions representing the sines. The sum of these fractions will therefore be simply the sum of their numerators, divided by C D. But the sum of the numerators gives us simply $AO = r$, so that the sum of the sines is

$$\frac{r}{CD} = \frac{r \times 2n}{\pi r} = \frac{2n}{\pi}.$$

Dividing this sum by the number of divisions, n, we find for the mean value of the sine $\frac{2}{\pi}$. Hence

The mean value of a simple sine function is equal to its maximum value, multiplied by $\frac{2}{\pi}$.

Since $\pi = 3{\cdot}1416$, we thus see that the mean value of a sine function is about ·637 of its maximum value.

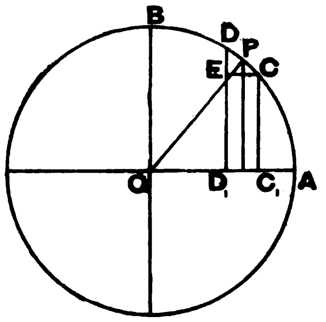

FIG. 47.

57. We have next to consider the R.M.S. value of a sine function. As before, this may be obtained from the *maximum* value by multiplying by the R.M.S. value of the sine. In order to determine the latter, we notice that the relation

$$\sin^2\theta + \cos^2\theta = 1$$

holds for all possible values of the angle θ (Art. 8.). From this it at once follows that

$$\text{mean value of } (\sin^2\theta + \cos^2\theta) = 1,$$

or, $\qquad$ mean value of $\sin^2\theta$ + mean value of $\cos^2\theta = 1$.

Now, since the cycle of changes through which the cosine of an angle passes is precisely the same as the cycle through which the sine passes, it follows that the mean value of $\cos^2\theta$ is the same as that of $\sin^2\theta$. We therefore have

$$\text{mean value of } \sin^2\theta = \text{mean value of } \cos^2\theta = \tfrac{1}{2},$$

and the R.M.S. value of the sine or cosine is thus seen to be $\frac{1}{\sqrt{2}}$. Hence

The R.M.S. value of a sine function is equal to its maximum value divided by $\sqrt{2}$.

Since $\sqrt{2} = 1{\cdot}414$, $\frac{1}{\sqrt{2}} = {\cdot}707$, and we see that the R.M.S. value of a sine function is ·707 of its maximum value. Comparing this with the result obtained for the mean value (Art. 56), we see that the R.M.S. value of a sine function exceeds its mean value by an amount which is about 10 per cent. of the former. The *form factor* (Art. 53) for a sine function is $\frac{{\cdot}707}{{\cdot}637} = 1{\cdot}11$.

58. We now pass on to the consideration of the *power* in an alternating-current circuit. At any instant the power is given by the product of the impressed E.M.F. into the current. Our object is to determine the *mean* power over a period. We shall, in the first place, consider the mean value of the power in a circuit whose inductance is negligible. In such a circuit we have at any instant

$$\text{current} = \frac{\text{E.M.F.}}{\text{resistance}},$$

$$\text{so that R.M.S value of current} = \frac{\text{R.M.S. value of E.M.F}}{\text{resistance}}.$$

Again, we have at every instant

$$\text{power} = \text{E.M.F.} \times \text{current} = \frac{(\text{E.M.F.})^2}{\text{resistance}}.$$

$$\text{Hence, mean power} = \frac{\text{mean (E.M.F.)}^2}{\text{resistance}}$$

$$= \text{R.M.S. value of E.M.F.} \times \frac{\text{R.M.S. value of E.M.F.}}{\text{resistance}},$$

$$= \text{R.M.S. value of E.M.F.} \times \text{R.M.S. value of current.}$$

We thus arrive at the following important result:

In a circuit of negligible inductance, the mean power, in watts, is equal to the product of the E.M.F. in volts into the current in amperes.

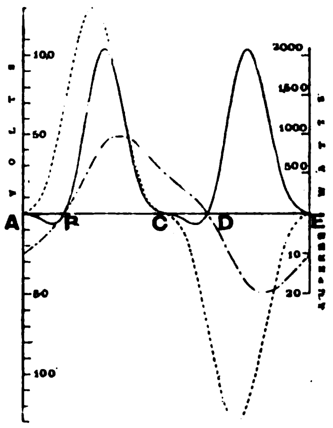

FIG. 48.

The student will notice that this result is true for waves *of any shape*, as we have made no assumption regarding the wave shape in the above reasoning.

We may, therefore, determine the power in any *non-inductive* part of a circuit by measuring the P.D. and current, and taking the product of these two quantities.

59. The above simple rule ceases to hold when the circuit is an inductive one. If the E.M.F. and current waves are known, we can easily determine the mean power by the method already explained for finding the mean value of an E.M.F. or current wave. We have merely to divide a half-period into a convenient number of equal parts, and determine the power corresponding to the middle point of each division. By adding the values so obtained, and then dividing by the number of divisions, we obtain the mean power in the circuit.

The difficulty which arises in the determination of the power in an inductive circuit is due to the fact that in such a circuit we have, as has been already explained, two E.M.F.'s, the impressed E.M.F. and the induced E.M.F. (Art. 37). During a certain fraction of every half-period, the induced E.M.F. is greater than the impressed E.M.F., so that *the current flows against the impressed E.M.F.* If the student will refer to Fig. 29, he will notice that the impressed E.M.F. is, during a certain fraction of each half-period, of opposite sign to the current. Now in accordance with the principle explained in Art. 27, an E.M.F. which is opposed to the current in a circuit becomes a *sink* of energy. During a certain fraction of the half-period, therefore, the source of alternating E.M.F. *absorbs* energy.

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This means that an alternator working on an inductive load acts as a *generator* during one part of every half-period, and as a *motor* during the remaining part. We thus have a periodic storage and discharge of energy in the circuit, the energy being temporarily stored in the form of a magnetic field surrounding the circuit (Art. 32).

In Fig. 48 the dotted curve is an E.M.F. curve,* and the chain-dotted curve shows the corresponding current curve in a circuit of resistance 3·95 ohms and inductance ·00786 henry, the periodicity being 80 ⁀‿ per second. The full-line curve is the *power* curve, and shows the manner in which the power fluctuates during a period. Between the points A and B, and C and D, the impressed E.M.F. and the current are of *opposite* sign, hence the power is *negative.* Between B and C, and D and E, they are of the *same* sign, hence the power is positive. If at any instant the power is *positive*, then this means that the source of alternating E.M.F. is acting as a *generator*, and supplying energy to the circuit; if, on the other hand, the power is *negative*, then the source of alternating E.M.F. behaves as a *motor*, receiving energy from the circuit.

In order to determine the mean power in the circuit we divide the half-period, A C, into 10 equal parts, and erect perpendiculars to the axis of time at the middle point of each division. The lengths of these perpendiculars we find to be

$$-20, \ -100, \ -100, \ +300, \ +1{,}300, \ +2{,}020, \ +1{,}800, \ +900, \ +250, \ +20.$$

Their sum is 6,370, and hence the mean power is $\frac{6{,}370}{10} = 637$ watts.

Using the method explained in Art. 53 for determining the R.M.S. value of a periodic function, we find that in the present case the R.M.S. value of the E.M.F. is 73·8 volts, while that of the current is 12·7 amperes. The product of the volts and amperes is therefore $73{\cdot}8 \times 12{\cdot}7 = 937$. But this product, as we have just seen, does *not* represent the true power in the circuit, and is sometimes spoken of as the *apparent watts* in the circuit. The ratio between the *true watts* and the *apparent watts* is termed the *power factor*, and this ratio is a very important quantity from a practical point of view. In the case under consideration, the power factor is $\frac{637}{937} = {\cdot}68$.

60. When the circuit is non-inductive, the apparent watts equal the true watts (Art. 58), so that the power factor is unity. It is in all cases desirable to have the power factor as large as possible, for an increase in the power factor always means an increase in the economy of working. Thus, let us suppose that a certain inductive load is worked by two alternators of the same output, the power factor being ½, and the current supplied by each alternator being the full-load current. Now, although each alternator is supplying its maximum *current*, it is only running at half-load, and so is the engine driving it. Let us contrast this state of affairs with that in which the power factor is unity. Supposing that the P.D. and load are the same in both cases, it follows that only half the current will be required in the second case. Hence a single alternator running at full load will be sufficient, and it is obviously more economical to run one alternator at full load than two alternators at half-load.

There are also other advantages of working with a high power factor. For a given load, the current varies inversely as the power factor. Hence, the rate at which energy is dissipated by heating of the circuit will vary inversely as the *square* of the power factor. Also, the drop of potential along a given line will vary inversely as the power factor. For both these reasons it is desirable to maintain the power factor as high as possible.

A bank of incandescent lamps, or of closed magnetic circuit transformers *fully loaded*, constitutes an arrangement for which the power factor is practically unity. On the other hand, a load of closed magnetic circuit transformers with open secondaries, of open magnetic circuit transformers (whether loaded or not), and of alternate-current motors, furnish examples of cases in which the power factor may be very small. The power factor may be increased by the use of condensers. This effect will be discussed later on.

* The E.M.F. in this example is represented by the two simple harmonic terms $100 \sin pt - 30 \sin 3pt$.

(To be continued.)

NOTES ON ELECTRIC LIGHT IN SEA-GOING VESSELS.

BY E. CRAIG-BROWN.

For one who has not actually had experience in the practical running of electric installations both on land and at sea it would be difficult to properly realise the enormous difference between the two practices. An electrician who had learned his calling in one of the magnificent central stations now to be found in nearly all our towns of note, or who had had charge of private installations, however complicated or troublesome, would find himself at sea in more than one sense if suddenly asked to run the electric lighting plant of one of our large ocean-going steamers. Besides having to face many difficulties entirely new to him, he would be led sadly astray if he attempted to cure with his shore-going remedies troubles that he fancied he recognised from his shore-going experience. They might be the same troubles to all outward appearance, but as often as not arising from widely different causes.

And why is all this difference? Does the engine not get steam from the boiler, the dynamo energy from the engine, the leads current from the dynamo, and the lamps from the leads? These are general questions, and to them the answer is, of course, "Yes," but if we begin to examine the *details* of working we must qualify that answer. The engine certainly gets steam from the boiler, but at sea the electrician as a rule has nothing to do with that boiler. He must take his steam as he gets it—*i.e.*, as made for the main engines.

Again, "Does the dynamo not get energy from the engines?" "Well, not always." In the latest marine plants where direct-driven machines are installed, of course the dynamo gets what the engine can give, but in many engine-rooms the old friction gears are still to be seen.

The following may explain what is meant: *Scene*, engine room of deep-sea steamer; *time*, say, 10.30 p.m. All going sweetly, main engines running well, engineers in good humour. Electric department satisfactory, voltage good, electrician also in good humour. *Group* consisting of the engineer on watch, the boilermaker, and the electrician spinning yarns under the lamp near the starting gear. Ghost-like "panee-wallahs" flitting about with oilcans and handfuls of waste amongst the plunging rods and levers overhead. Suddenly, in middle of boilermaker's best story, "Cri-i-i-n-n-n-n-n-g!!" goes the telegraph, "stop." "Cri-i-i-n-n-n-n-g!" again, "half astern." A second's pause; then the boilermaker is running up the ladder with a spanner to stand by that troublesome reversing gear on the H.P. eccentrics; the engineer is unlocking the levers, and the electrician is replying to the bridge by the telegraph. That done, he rushes to his machines. The "fourth" has pulled over the levers and is hanging on to one of them, the little starting engine has begun to work, spitting, knocking, and sticking. A little help to "the wheel" by hand, and it is flying round, the oil coming off its rim tangentially and going on to the faces of the electrician's friction pulleys. The main engines slow down, and the extra steam thus left in the boilers sends up the pressure. The dynamos whirr, up goes the voltage till the lamps look like melting, and at the same time up goes the electrician's hand to the regulating valve. Too late; what with the sudden increase of speed and the oil from the starting wheel the friction is overcome and the pulleys slip. Down go the lights, up goes the smell of burning oil and resin, and the dynamo engine races as if it would knock itself in pieces. In vain does the electrician apply his best pocket-handkerchief to the pulley faces; the initial friction having been overcome nothing short of slowing down and the judicious application of powdered chalk to their faces will cause the pulleys to "grip" again.

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By this time the cause of the sudden stoppage becomes known. [Run into a Chinese fishing fleet off Fu-chow-fu, or something of that sort.] The telegraph signals "slow a-head," and the chief engineer is anxious to know "What's wrang wi' they —— machines again, as the captain has been speerin' at him aboot the lichts?"

To continue, "Does the dynamo not supply the leads with current?" "Well, yes, in a way. The positive lead gets all that doesn't leak from the brush rocker into the hull of the ship." You see (unless our electrician is lucky and has one of these slow-speed drum armatures to manage) the motion of the ship has to overcome a very considerable amount of gyrostatic action in the armature. The bearings, therefore, are subjected to heavy work, and if they are lined with white metal he gets rather anxious about them on a rough night, so anxious that sooner than see them running out at the end of the spindle from overheating, he is lavish with the oil. As their temperature still increases, however, he borrows some snow from the refrigerator man and applies it to the outside of the plummer blocks. It *may* keep the bearings from getting too hot, but it certainly *does* run everywhere when it melts, even over his vulcanite washers, and leakage follows as a matter of course. Speaking of rough nights, if he is not used to them, he may have occasion to go on deck several times "to see if there is much phosphorescence in the sea." During his absence the machines are left more or less to themselves, as the engineer on watch may not be conversant with dynamos.

Now for the leads themselves. There are three systems—viz.: (1) double, (2) single, and (3) concentric.

(1) The double leads are on the same principle as those on shore—*i.e.*, one positive and one negative.

(2) The single system is the oldest, as it is the one that would naturally occur to a telegraph electrician. The negative wire is put to "earth" on the nearest bulkhead. This is better than merely taking the insulating washer out of the negative brush-holder. Similarly the return wires from each lamp have to go to "earth." This, of course, entails much drilling and tapping of ⅜in. holes in plates for terminal screws.

(3) The concentric system is used chiefly in the Royal Navy, and where expense is not the chief consideration it is undoubtedly the best. Jointing requires a trifle more skill and patience than in the other systems. Making a joint ashore is one thing, at sea quite another. Picture the electrician trying to stand on a camp stool in a cramped and dark corner of an alleyway with a rapidly cooling solder bolt in one hand and a stick of solder in the other. The ship is pitching and rolling, so he has to steady himself by pressing his head against the ceiling. Temperature, say, 90 something, and vision imperfect, owing to excessive and continual perspiration. The most angelic temper sometimes gives way in such circumstances. The following table, though by no means exhaustive, gives a few of the principal arguments for and against the three systems:

DOUBLE.

Advantages.

1. Less tapping of plates required.
2. Fewer sources of short-circuit and leakage.
3. Less likely to affect ship's compass
4. Danger of shocks to passengers a minimum.

Disadvantages.

1. More drilling of plates required.
2. Greater initial expense.
3. Chances of rupture by straining of ship or corrosion by sea-water doubled
4. More time and trouble to alter or repair.
5. Double casing necessary and therefore more space occupied.
6. Double cut-out fuses almost a necessity.
7. Not impervious to damp.

SINGLE.

Advantages.

1. Simplicity and cheapness of installation.
2. Single casing used, and therefore greater economy of space.
3. Repairs simple and faults easier to locate.
4. Fewer and simpler cut-out fuses required.

Disadvantages.

1. Tapping plates for earths.
2. Danger of shock from faulty or damp switches.
3. Chances of short-circuit and leakage all along leads.
4. Chance of deflecting ship's compass.
5. Not impervious to damp.

CONCENTRIC.

Advantages

1. Casing only required where there is a chance of rough usage—*e.g.*, when second-class accommodation is utilised as cargo space.
2. Great economy of space.
3. Less unsightly than other systems.
4. Short-circuit and leakage a minimum.
5. Less danger to compass.
6. Danger of shock a minimum.
7. Impervious to damp

Disadvantages.

1. Initial expense.
2. Greater skill necessary for repairs.
3. Liable to damage by indentation.

With reference to disadvantage No. 2 in the single system, the pressures commonly used on board ships are never high enough to do anybody harm, but a timid person who tries to turn on a switch while standing in a bath may be somewhat startled if the splashes and general dampness of the average ablution room have got behind the porcelain cover. Of course all leads, whatever be the system, must be easily got at along their entire length, while switches and fuses must be located in convenient places. In saloons, leads are often run behind panelling. When this is done, the panels must be so constructed that they can be easily removed and replaced. Some skill and experience are required to run leads successfully in a ship. Casing cannot be nailed up at random and wires carried through walls as on shore. Laborious drilling and tapping of holes in bulkheads is necessary, so the problem is to run the leads efficiently with the minimum number of holes.

There should always be two (or more) entirely separate circuits in a ship, one for each dynamo; and one lamp at least in each room should be on a different circuit from the rest, so that should one machine fail suddenly the room may not be left in perfect darkness. Thus, from sunset to "lights out" both machines are running, and all the lamps may be burning. At "lights out" the day circuit is shut down and the night circuit goes on till daylight. In a passenger vessel the following would roughly be the arrangement: *Day circuit*—saloons, smoking-rooms, alleyways, etc. *Night circuit*—one or two lamps in saloon, ditto in alleyways, engine-room and stokehole, cabins, quarters, cargo lamps, etc.

The switchboard in the engine-room should allow of either unit running either or both circuits. As the night circuit is on much longer than the day, it should be run alternately from one or other of the units so that the work is not thrown too heavily on one machine.

Vessels fitted with a searchlight projector should have the circuits arranged so that when it is in use one unit is entirely at its disposal and both circuits are on the other. To reduce the load on the machine that is thus running both circuits, all lamps that can be reasonably done without should be disconnected for the time being. These arrangements are, of course, for vessels in which the searchlight is seldom used, otherwise a separate and distinct installation should be fitted for the projector, independent of the other machines and circuits altogether. Of course, in any case the projector leads would run direct from the switchboard to the instrument, untapped and independent of any others. *They* should never be on the single-wire system, and the fuses should be as strong as the safety of the dynamo will allow. With all hand-regulated projectors the resistance of the circuit is liable to sudden and frequent variations which test fuses to their utmost and render necessary the constant services of a dynamo attendant.

With reference to lamps, the spherical, dimmed-glass globe hanging from three arms projecting round the end of a pendant or bracket fixture is an excellent arrangement, and would be hard to beat for simplicity and convenience. The bayonet lamp socket is the best. That kind of lamp which is attached to two spiral springs by little platinum loops is too great a temptation for the curious. Their zeal for experiment leads them to put the blade of a knife across the terminals, and then, if the lamp fuse does not go, the branch one very likely will, and the place is suddenly darkened. One improvement suggests itself, however, on the metalwork of the fixture. Instead of having it of

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brass, polished or lacquered as at present, have it rough cast or bronzed, for the following reason: In a ship, from the captain downwards, there is a universal and incontrollable mania for polishing brass. As long as it is confined to handrails, binnacles, lubricators, etc., it is to be encouraged, but when the chief steward casts his eagle eye about the saloon and sends a Portuguese waiter to polish the lamps, it is time to draw the line. The waiter, armed with polishing paste and a cloth, mounts the table or a camp stool and steadies himself by hanging on to the lamp with one hand, while he rubs it vigorously with the other. Every time the ship rolls or pitches a large part of his weight comes on to the bracket, and it is not long before it ceases to have any claim to be called a "fixture." Once loosened, every movement of the ship tends to increase the mischief. Now, if the chief steward saw that these fittings were not meant to be polished, he would leave them alone, and much trouble and annoyance would be saved all round.

Vibration is another source of trouble, inasmuch as the incandescent filaments often shake till they touch the glass of the lamp bulb. This cracks the bulb, and admits air, if it does not at once sever the filament. This may often be avoided by turning the socket so that the plane of the loop is coincident with that of the arc through which the filament tends to vibrate (Fig. 1). In this illustration the arc through which the filaments tend to vibrate is shown and marked A B. The position on the left is the best, as the filament is more stable, while the position of the filament shown on the right is bad.

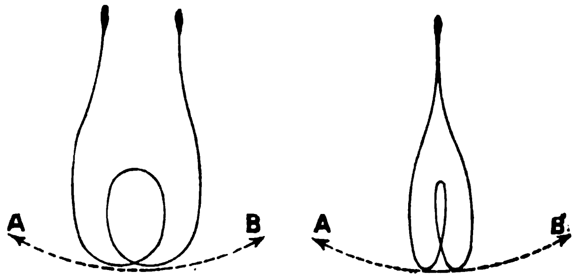

FIG. 1.

Wherever dual control exists there is also a mine of provocation. This is exemplified at sea, not only by the steward's desire to polish the electrician's lamp fittings, but also by the delight quartermasters have in rendering useless the flexible cable connections on cargo lamps. Perhaps the fault lies as much with the connections as with the quartermasters. As a rule they are made only to conduct electricity, not to take any tensile stress. This is a mistake. The quartermaster screws the terminal on to the socket all right, as he has been taught, but he adds a good sailor-like tug to see if it is firm. This ruptures the flexible strands and out goes the cluster. Failing a better designed type of terminal screw, a strong light line should be rigged alongside the cable to take the strain, the cable to be looped up on to it as may be seen overhead in streets where a strong steel wire takes the weight of a heavy conductor.

On board ship space is limited, and therefore must be economised. This tends to cramping. Engines and dynamos are stowed away in odd corners, the trouble of cleaning and repairing being thus greatly increased. An electrician used to a spacious central station on shore with everything up-to-date misses a hundred and one little conveniences, and finds them replaced by worries he never dreamed of before. Refitting crankhead brasses, inspecting pistons, and the like, are operations requiring skill and patience in any circumstances. When they have to be carried out in a hot, dark, stuffy, and dirty corner, somewhere in the bottom of a marine engine-room, only one who has actually experienced them can realise what a lot of work they entail. Yet at sea there must be no scamping or shirking of work: the safety of the ship may rest on the merest detail. It is very pleasant to lie in an easy-chair on the hurricane deck when off watch, but it is absolutely necessary to finish your engine-room work first.

THE RECENT TELEPHONE CONVENTION IN AMERICA.*

BY FRED DE LAND.

It was a happy thought that resulted in the election of Judge Barstow as the presiding officer of the convention, for the honourable judge is a prince among optimists, and a firm believer in the gospel of good cheer. Thus, no amount of croaking could entirely dispel that hearty cheerfulness that permeated every session. To be sure, now and then the discussions were tinged with melancholy, and on the whole the proceedings were of a depressing character, but the judge was as bland as the honey of Hyblea. What matter if Waukesha had "ceased business and sold the plant for a nominal sum, sufficient to cover outstanding indebtedness, leaving the original investment a total loss"; that La Grange had gladly laid down its burden and pocketed the loss; that Selma's doors had been slammed in the face of an ungrateful public who could now pay the higher rates of the Bell Company, simply because they desired some return on an investment that ought to have been given freely from a sense of pride in a home institution? To be sure, the officials admitted that the prices charged and the service rendered were so unsatisfactory that the service had to be abandoned, but their opinion was naturally biassed. Or that St. Joe was wondering how so much money could be for ever lost so quickly, though the local Press laid the blame on "unsatisfactory service—want of out-of-town connections, inferior appliances to the Bell Company, and a rate too low to enable them to attempt a comprehensive service." Suppose the competing telephone plant at Nevada that cost £400 was sold for £30, and that the Pittsburg plant on which over £600 was invested was disposed of under the hammer for £120. Did not the smooth promoter get away with his commission? What if the courts have ordered the notorious Harrison Topeka telephone plant to be sold to satisfy judgments aggregating £6,000. Is there not an abundance of wealth yet remaining in Kansas yearning for just such profitable investment? And who can locate a soft mark quite so quickly as the slick telephone promoter who was the understudy of Dusty Rhoades but a brief space agone? Why should the learned judge care if the Florida long-distance telephone system was disposed of for £30 at Orlanda by a brutal sheriff clothed with a little brief authority? or that the Ypsilanti automatic telephone exchange had been discontinued? The judge was content to look upon the bright side of life, even if 12 members had been side-tracked by the sheriff or for some similar reason since the last meeting, for he well knew that though the hot sun was now roasting the members, yet with the opening of the gates of night would come the stars, and the cooling breeze, and the refreshing sleep, and in that land of dreams that yet may prove to be the real world there is no worry over doomed financial ventures voluntarily assumed; so why worry?

And having called the meeting to order, the judge declared the convention of independent telephone companies open, and directed the calling of the roll. This being done, the secretary reported a gain of 22 new members and a loss of 12 members. As the names of these 12 delinquent members were called, only harsh and unpleasant comments were heard on every side, due, apparently, to no other cause than that some among these ill-fated 12 had allowed an uninvited and ill-bred deputy sheriff to enter their respective exchanges and levy on the entire plant, merely to satisfy claims for small amounts of filthy lucre. But the judge rapped for order, and said the remarks were uncalled for. "We should learn to bear easily the misfortunes of our friends, and, with Euripides, remember that that man is wise among us, and hath understanding of things divine, who hath nobly agreed with necessity."

After the various committee reports had been read and disposed of, the meeting was declared open for the discussion of special topics germane to the best interests of the association, and the chair urged the members to participate in a full and spontaneous expression of opinion on the

* From *Electrical Engineering*.

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rumoured consolidation of all the property interests of the principal Bell licensees and their absorption by the parent company, thus doing away with the royalty fee and effecting a marked reduction in the operating expenses, enabling them the better to meet competition. The chair also desired that the sentiment of the association be placed on record regarding the attitude of the manufacturing telephone companies towards the operating telephone companies. He did not believe that the manufacturing companies were standing up as manfully as they had agreed to, and there was little doubt in his mind that the independent exchanges would have to fight their own battles, while the manufacturing companies exhausted their energy in petty internal squabbles. Thus he believed that the association was not interested so much in what the telephone manufacturing companies were going to do, as whom; for experience had shown how honest they could be when certain of being detected. Nor would he advise any member to lean on any telephone manufacturer for legal assistance in defending the suits the Bell Company would certainly institute. For, basing his opinion on personal observation and the published statements in the electrical Press, the chair felt confident that the affairs of these manufacturing companies were in such shape that they could immediately close down or assign in the event of the United States Supreme Court again deciding in favour of the Bell interests. Thus, it is really the part of wisdom to look upon the bond and the guarantee of telephone manufacturers as absolutely valueless, for the Court proceedings already taken show that some, if not all, "are pecuniarily irresponsible and unable to respond to a decree for damages in favour of the complainant in this suit."

The question was asked by one of the members whether there was any reliable information on record regarding the financial standing of the Home Telephone Company claiming several thousand subscribers in many cities, according to the very reliable electrical journals. The secretary replied by reading extracts from a report on the Committee on Telephones for the district of Columbia, on Bill S. 2,498, showing a claim on the part of the promoter of having secured 3,400 subscribers in the district of Columbia at a rate of £8 and £6. 8s., taken from "the portion of the business people of the city who have not been so successful in life, and who have no particular use for the more expensive metallic connection." "We expect to serve people who cannot quite afford to use telephones unless this company is chartered." The gist of the testimony showing that "if the franchise were granted to-day, two years from now would not see 200 commercially working Home telephones in the district of Columbia, if any." The secretary also read extracts from the Cleveland *Plain Dealer* and the Cleveland *Leader*, of May 12, 1895, showing that the Home Company "has no serious intention at present of going ahead with its project." Yet in each city they were successful in disposing of privileges, stock, etc., at good prices. These comments reminded the president of the story of the practical politician who boasted that he had made £50,000 in the last two years, "but I worked for it." "Of course you did," was the reply, "but whom did you work?"

Mayor Pingree's Detroit Telephone Company, that is to be operated for 50 per cent. less than the present exchange, next came in for a fair share of criticism for masterly inactivity, and in closing this discussion later on, the chair remarked that the good mayor's comments on the absence of proper protection for the rights of the people were worthy of the able politician who said that all knowledge which does not increase a man's virtue makes him the more dangerous. And he recalled a brief conversation between two politicians accidentally overheard in one of the lower wards in his city: "You look done up, Chimmy. Is it worryin' yuh to make all those reform speeches to the people of your ward?" "It isn't the reform speeches, Tim, it's the work of gettin' the boys to understand how I don't mean 'em, that's worryin' me." The deduction drawn from the printed statements issued by this Detroit Company is that with an average telephone rental of £6. 16s. a year for 5,000 telephones, 10 per cent. dividends can be paid on £120,000 in capital stock, and 6 per cent. on £80,000 in bonds. And all purchasers of stock would be given an equal amount of interest-bearing bonds. In other words, this "reform" organisation would not pattern after the highly improper methods adopted by the grasping corporations so heartily denounced by his honour, "the friend of the people," but would add the water before winning success. In the prospectus issued by the Pingree-Detroit Company earnings and expenses are itemised, thus enabling a comparison to be made with the present expense account of the Bell Company in Detroit, having 4,300 subscribers. Female switchboard operators, Pingree Company, 60 at £1 a week, or £3,000 annually; Bell Company, 107, averaging 24s. per week, or £6,677 annually. The Pingree Company will have ten linemen and three labourers at an annual outlay of £1,500, while the Bell Company finds it necessary to keep 56 linemen and inspectors continually employed at an expense of £6,720. Batteries have to be renewed every few weeks, this item aggregating £2,000 annually for the Bell Company, yet the Pingree Company make no provision for this very necessary expenditure. For new material and repairs to Bell circuits nearly £5,000 are expended annually, yet the Pingree prospectus makes no allowance for this, nor for depreciation, though in 1893 the Bell Company replaced a switchboard that cost £10,800 with one that cost £24,800 and had previously discarded boards costing over £12,000. Yet the Pingree Company add: "And on every additional 1,000 telephones used, the net profit per annum would be £5,000, the ratio of profit being higher as subscribers increase."

The member from Pittsburg suggested that the Pingree Company should secure the services of the bland promoter who has been weaving his meshes about the gullible citizens of Kansas City, as he possessed the ability of operating an exchange of 3,000 telephones at a total expense covering all items averaging but £2. 8s. per telephone, while the Pingree Company allowed the extravagant sum of £3. 1s. 3d. per instrument. To be sure, the Bell Company claims that it costs them about £12 an instrument to operate their exchange, but who believes the fairy tales of successful dividend-paying corporations? Then this Kansas City weaver offers his telephones at only £6. 8s. a year, and his circular clearly demonstrates that if only 3,000 telephones are rented at this figure the annual income will be £19,200, the total annual expense £7,200, leaving the handsome net income of £12,000, or a return of 12 per cent. on an investment of £100,000. But for fear that the holders of this stock may become proud in spirit, the weaver limits the number of shares that any one person should hold to 10 shares of £20 each.

Comment was also made on the promised competition that has failed to materialise in Chicago, Philadelphia, St. Louis, and other large cities, and to the feeling of pride that must permeate the bosoms of Messrs. Clarkson, Egan, Tracy, Aldrich, Porter et al., when they gaze upon all that has been accomplished.

Incidentally, the chair remarked that there was ample legal talent both within and without the association ready for sacrifice in fighting this gigantic monopoly—for a consideration, but that he had fully made up his mind that the only safe course to pursue, when the United States Supreme Court delivered its opinion sustaining the validity of the Berliner patent, was to surrender and have his loss as small as possible, unless in the meantime he could find some good-natured relative on whom he could unload his holdings in the independent exchanges.

Here the member from Oskaloosa interrupted the president's remarks by asking if he could name an actual independent exchange; there were plenty of dependent exchanges dependent on the holders of overdue notes and mortgages; but an independent competing exchange? Impossible! One of the exchanges in Iowa was so anxious to be absorbed by the Bell or any other company without money and without price that its beseeching attitude reminded him of the tramp's reply. Weary Willie had entered the yard with the firm intention of disabling all competition, but by a masterly retreat he had scaled the fence just in time to escape the fangs of a savage bulldog: "Madam, I did intend to demand something to eat, but all I ask now is that, in the interests of humanity, you'll feed that dog."

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The next question that came up for discussion was the advisability of erecting toll lines. One of the members appeared bent on forcing each company to bear its share of an assessment that would enable interconnecting lines to be built and thus afford subscribers in one exchange full communication with the subscribers in any other exchange in the state. But he talked so long and digressed so widely that when he finally subsided someone was cruel enough to intimate that there are a great many ginger-pop people in the world. After they have been uncorked for a few minutes they get to be dreadfully flat.

Mr. Cleveland doubted the wisdom of erecting many toll lines "until we have had more experience in this business. If we do we shall probably have good cause to regret the outlay. For few toll lines have proved to be a profitable investment, either in the East or the West. Take the lines that connect the small outlying village exchanges with any large city, and the income rarely equals the operating expenses, while the deficit—to make good the cost of maintenance and the fixed charges—must come out of the income of the city plant which creates and maintains a toll line and exchange for the convenience and benefit of its city patrons, rather than from any expected profit that would accrue from village conversations. Rarely will the public pay more than ½d. a mile for short distances of 50 miles or less, and ¼d. for distances exceeding 50 miles, and as an average of only five conversations per hour can be held over any ordinary toll line, the income never justifies the outlay save from the standpoint of favouring the subscribers of the large exchange."

A spirited discussion followed, in which nearly every member participated, but it was soon evident that some prearranged plan existed for forcing the association to endorse a movement in favour of toll lines. The minority protested against any action that necessitated further expenditures of moneys. Toll lines were necessarily expensive to build properly, as well as difficult to maintain in good working order in this section so often visited by severe storms, while it was doubtful if the receipts would ever equal the cost of operating the lines; and as not one shilling of legitimate profit had yet been secured from any investment in these small independent exchanges, any motion to increase the investment until a dividend had been declared would meet with determined resistance. Even with their more profitable rates the Bell Companies did not dream of general toll lines for several years after the principal exchanges had been established, and only since August 1 has it been possible to talk direct from Davenport to eastern points over the long-distance trunk lines.

Mr. Cleveland said that he fully appreciated the great value to a local exchange of the right of way for transmission of messages over trunk lines, and he felt that in the near future some concerted action that might bring about interstate connections would be not only desirable but absolutely essential to preserve the integrity of the capital already invested. But this was not the time nor the place to adopt coercive measures. No one appreciated more fully than he did the great value of the telephone as a time-saver to business men, and he had heard of many instances of men travelling by rail to Chicago and then using the long-distance lines to close some important deal in Boston or New York, or some Eastern city. But these long-distance trunk lines were owned by a separate company, and built and maintained by capital invested independently of any investment in the local exchange. No doubt an independent long-distance company might be formed, but he did not care to invest any money in such an enterprise. To build a pole line properly and string two wires for one complete metallic circuit would cost £80 to £90 a mile; additional circuits could then be added from time to time as the traffic justified, at comparatively small expense. Yet, he understood that toll lines had been built for £50 a mile, and rebuilt after the first heavy storm. Even the lines in the city of Madison, the headquarters of a branch of promoters, could a tale unfold were they inclined to be talkative.

Mr. Bartin defended the other side of the question by saying that experience had taught some very good Wisconsin people that profits can only be realised when capital is invested in a productive enterprise operating more fully, more satisfactorily, and at less cost than existing competition, and more especially is this true of public or semi-public service plants, where the ultimate profitableness of the investment is so largely dependent on the general acceptance of the service supplied. This was well illustrated in the case of the Waukesha telephone exchange. No Wisconsin town enjoys so many advantages, so many well-to-do, progressive, and public-spirited citizens, who never hesitate to make any investment that will aid in building up their town, and make it still more famous, not only for its beautiful surroundings and its health-restoring mineral waters, but for the public conveniences afforded the citizens. Thus, when a new telephone exchange was proposed ample capital was quickly forthcoming, and in a short time an excellent exchange was in operation, with a large number of subscribers, and there was every indication of it being a prosperous undertaking. But after the third or fourth month the receipts began to drop off, and gradually one subscriber after another relinquished the service until the plant was sold for a sum that merely covered the current bills, leaving the original investment a total loss. The explanation is easily given. It was not so much a question of the inferiority of the instruments or the indifferent service furnished, as it was the absence of all toll-line connections. Now, the majority of the well-to-do residents of Waukesha have their places of business in Milwaukee, Chicago, or in one of the towns in the valley, and necessarily must have telephonic communication that is at all times available to those points. Thus, when they found that the new telephone circuits were limited to the subscribers within the town, and that to have constant telephone facilities with outside places it was necessary to also subscribe to a Bell instrument, they naturally came to the conclusion that a second telephone was of no real value and quickly dropped it. And thus, while the new exchange had more subscribers than the old Bell Company at the start, the new company could not give the service demanded, and thus had to close its doors. And Mr. Bartin believed this would be the fate of every exchange represented in this convention, unless they joined in the building of interconnecting lines that would enable them to give the class of service any customer might desire.

The report of secretary E. M. Hopkins, of the Board of Trade, Saginaw, Michigan, who was commissioned to investigate and report upon the advisability of establishing a competing telephone exchange in Saginaw City and the Valley, came up for consideration, and was severely criticised because of his adverse decision. Mr. Hopkins reported that "There is one conclusion you quickly reach, and that is that someone has been lying about the telephone business. You cannot by any possible reasoning reconcile the figures put forth by telephone company promoters and the Bell people. They are as far apart as daylight and darkness. . . . Judge Gages states that each individual subscriber to the stock of a telephone company is individually liable for all material and labour used." And his recommendation was adverse to investing any capital in a competing telephone exchange "until the decision of the Supreme Court is had in October."

[The foregoing description will convey to our readers some idea of the present state of the telephone industry in America.—Ed. *E. E.*].

Wedding.—The marriage of Mr. Harold Faraday Proctor, second son of Mr. Barnard S. Proctor, of Newcastle-on-Tyne, and electrical engineer to the Bristol Corporation, and Miss Amy Peckett, youngest daughter of the late Mr. Thomas Peckett, of Hyde Lodge, Durdham Down, took place at the parish church of Westbury-on-Trym. The bride was given away by her brother, and her two sisters were the bridesmaids. Among the wedding presents was one from the members of the Bristol Electrical Committee, who presented Mr. Proctor with a handsome silver tea and coffee service, suitably engraved. The staff at the electric lighting works gave a silver salver, and the employés at the works a fine engraving. The employés at Messrs. Peckett's engine works, St. George, presented a handsome timepiece.

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OPINIONS v. FACTS.

The differences of opinion between experts are likely to last until we reach the happy time when all men will be exactly equal, and hence expert advice will not be required. We hold that these differences of opinion are in many cases incentives to improvement; but that when they become active weapons for opposing progress, expert advice is worse than useless. Thus, for years in England we have had a keen fight between experts as to the ultimate advantages of the alternate and direct current systems of distribution. A few engineers have taken the broad-sided view of the matter, and have used both systems as the character of the town to be lighted demanded. Others, of whom the manufacturing side claim a large proportion, have taken a more party view of the matter, and certain small and compact towns have been equipped with high-tension alternating-current machinery in consequence. The difference between one shift of men and three then makes itself strongly felt. As a result the expenses of running have swamped the income, and the undertakings have not been financially successful. The comparison between the two systems now that high-voltage lamps have been introduced needs further consideration, and the use of high-tension distribution with rotary transformers has also helped the direct currents at periods of heavy load. The high-tension direct-current machinery, as used in several towns in England, equalises to a large extent the difference between the two systems. Still, opinions are free, but we do not like to see opinions hinder progress. After a certain company, for instance, has been working at a problem of town lighting for some time and has got some way towards commencing work, we do not believe in condemning their plans unless there is no chance of their success in practice. The electric lighting of Calcutta is thus jeopardised, as will be seen from the reprint of a contemporary elsewhere in our columns. As will be remembered by our readers, the question of the cables to be used was also well taken up by the same paper some few weeks ago. We see no reason why the company in question should not make the lighting of Calcutta a financial and electrical success with distributon on the low-tension system, with perhaps high-voltage distribution to the sub-stations, although we would agree with our contemporary that the alternate-current system might cost less in the first instance. Still, the comparisons drawn between the two are not complete, and the lack of several essential facts detracts from the value of the criticism. For instance, the comparison between the loss in the mains is given, and, as is well known, the low-tension system works at its worst efficiency at full load. Hence, as compared with the alternate-current system at full load, it would seem to be quite out of the running. Yet the other side of the question needs attention, and at light loads the positions are reversed. The transformer loss, of which we find no mention in the paper before us, reduces the efficiency of the alternating-current distribution to a low figure at such periods. In other words, the low-tension losses are large at a paying load, when

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these can be afforded. The fact of the increased cost of coal per unit sold in the alternate-current stations is mainly due to the losses in distribution, as the efficiency of the generators does not differ much. Another point in the report that strikes us as bearing hard on the low tension is the statement that "the alternate current affords the most remarkable facilities for the transmission and distribution of energy in the form of motive power." This is perfectly true, but the low-tension system affords even more remarkable facilities. Also, if a three-wire two hundred and twenty-volt service were adopted, as it can well be in the case before us, the facilities for supplying the tramway service would be most valuable. This fact alone, if there are fair prospects of traction work, should be a strong point in favour of the project now before the officials of the city of Calcutta. We wish the promoters every success, and trust that the features of the scheme other than technical to which our contemporary finds objection may be successfully negotiated. It is quite time that an important city like Calcutta should reap the benefit of the electric light, and we trust that differences of opinion may not prevent this desirable end.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

LEEDS TRAMWAY—CLERK OF WORKS.

Sir,—I read with considerable interest—as might be expected—your leading article on the above matter in last week's issue of the *Electrical Engineer*: and may now perhaps be allowed to express—without undue impropriety—my agreement with much that you say, as well as with the fundamental position taken therein.

When, however, you say that the applicants were "given to understand that the gentleman who should be chosen to act as clerk of the works during construction would most likely be appointed engineer afterwards," I would like to know whether your information was official in this respect or not. My own experience does not bear out the statement, except in so far as might be gathered from the fact publicly stated beforehand that the work was expected to be done in six months: for obviously a man of good professional standing would hardly expect to go to Leeds for a few months only.

Seeing that my name has appeared in connection with the post, I would like to say that (as my friends would probably guess) I was *not* the applicant who offered to undertake the work for the magnificent salary of 45s. weekly—that is, 15s. a week more than the Leeds Corporation pays to some of the tramcar drivers! — Yours, etc.,

Frank B. Lea.

DEAD-WEIGHT IN TRAMCARS—IS IT PROFITABLE OR PRACTICABLE TO REDUCE IT?

We hear much in these days of the wonderful load a bicycle carries in proportion to its weight, says the American *Street Railway Review*, and it is hinted often that cars weigh much more than they should in proportion to the loads they are expected to carry. Indeed, *Locomotive Engineering* remarks that "a study of the bicycle might prove a profitable pastime for the designers of railroad rolling-stock," and says, "the trend of car designers is to increase the proportion of dead-weight to paying load." This is more noticeable in steam-road practice than in street railway work, for although the weight of street cars has increased, it has been due more to the addition of electric motors and greater seating capacity than to any great increase of weight of car body per passenger. However, the weight of cars and motors is very great in proportion to the load they are ordinarily expected to carry, and it certainly is not out of place to investigate the subject a little.

In considering a matter of this kind there are two questions that immediately come up. First, is it mechanically possible to reduce the weight? Second, if it is possible, will it pay? As to whether it is mechanically possible there is not much doubt but that there might be some reduction in weight if roads were willing to pay for it. How much, no one seems inclined at the present day to state. That is something which could only be decided by long trial and experiment Before spending money in trying to answer the first question, the second question as to whether it might pay must be at least partially answered. That it is going to cost more to build rolling-stock lighter than it is now for the same weight of load is evident. How much can a road afford to pay for making its rolling-stock lighter?

For a concrete example let us take the case of a motor-car of a very common type—viz., a closed motorcar with 16ft. body and double motor equipment, weighing complete 11,100lb. Its seating capacity is 22, and the weight of car per passenger seated is 504lb. This seems like an enormous dead-weight, but it must be remembered that the car must be prepared to carry at times as many people as can crowd on, and in some cities it will be called on to carry 60 or more people several times a day. This would bring the dead-weight down to 185lb. per passenger. On open cars with seats running clear across the dead-weight per passenger seated is considerably less than with closed cars.

Suppose now that it were possible by more expensive construction, and in some places the use of different materials, to cut the weight of our 16ft. closed motorcar one-half without weakening it. How much is the reduction in weight worth to the operating company? The first and most important saving will, of course, be in power, although a reduction in car weight would be far-reaching in its effects, having an influence on the cost of construction and maintenance of the track, overhead feeders, and power station—three of the most expensive parts of a street railway equipment. If the weight of a car and equipment is reduced 50 per cent. it will theoretically reduce the power required to run it 50 per cent. However, as the various losses, both electrical and mechanical, will be proportionately larger for the light car, we will assume that reducing the car's weight 50 per cent. will reduce the power needed 40 per cent., which is probably a conservative estimate. The average cost per car mile for power taken from the tabulated reports on power plant performance, published in our contemporary's issue, April, 1896, was ¾d., and the yearly cost of running a 16ft. car will be figured on that basis. If the car runs 3,000 miles per month its yearly mileage will be 36,000, and the cost of power taken to run it that distance at ¾d. per car mile will be £108. Forty per cent. saving of £108 would be £43. 4s. a year, or enough to pay interest at 6 per cent. on an investment of £720. According to this the average road could afford to pay £720 more apiece for its motorcars than it is paying now if they could be reduced 50 per cent. in weight without sacrificing any strength. There are some roads where power costs twice the average amount assumed, and they could consequently afford to pay twice the amount estimated for the sake of lighter cars. On the other hand, there are some that get power for half the assumed figure, and they consequently could afford to pay only £360 more per car. This takes account only of power saving. There would be other economies, as before mentioned. If car, truck, and motor builders see anything in these figures that make it any inducement to attempt any great reduction in weight, there will, of course, be a move in that direction. Cutting down weight without losing strength is, however, an expensive process, and it is useless to try to predict what can or what cannot be done along this line. One thing should not be forgotten, which is, that the parts of a car are dependent on each other, and the lightening of one part allows the

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lightening of others. The lightening of a car body permits the lightening of the truck that carries it and the motors that propel it. The lightening of the motors in turn allows the trucks to be lightened, and so on.

METERS.

The following are the conclusions arrived at by Mr. James Milne in a paper read by him before the Canadian Electrical Association at Toronto. As the greatest part of the author's paper is devoted to the Edison meter, the gist of his conclusions can be understood. It is a pity, however, that he has not recognised any of the known defects in this type. He sums up the advantages and disadvantages of the various meters as follows:

The advantages of the Edison chemical meter are:

1. Practically no loss.
2. No moving parts.
3. Absolutely correct at all loads.
4. Will record the smallest possible amount of current.
5. It is applicable to any pressure.
6. Low first cost.
7. Low cost of maintenance.
8. Readily repaired.

The only disadvantage (if any) is that the consumer can't read it for himself.

Motor Meters.—The only advantage is that the consumer can read the meter. The disadvantages are:

1. Loss in overcoming friction in the moving parts.
2. Incorrect at light loads.
3. Incorrect at quickly varying loads.
4. First cost high.
5. Cost of maintenance high.
6. Not readily repaired.

Clock Meters.—In the Aron type of meter we have the following advantages:

1. Correct at all loads.
2. Will record the smallest possible current.
3. As a coulomb meter is applicable to any pressure.
4. Practically no loss.
5. Can be read by the customer.

The objections to this meter are:

1. Liability to stop recording if clock stops.
2. First cost high.

We therefore see as a practical meter the chemical meter is superior in every point save one, and that is, the customer can't read it for himself. Is this much of an objection? How many gas consumers read their meters? I know I am not very far out when I say that not over 2 per cent. ever wish to read their meters.

The Edison meter has been condemned by a certain class, either through ignorance of its principle or prejudice, and our Canadian Government has also seen fit to practically condemn it—probably not condemn it, but to curtail the growth of a meter that has no superior and very few equals.

It does seem strange to me that the Government should interfere the way it has done, and more especially with the electrolytic meter, when in the "Act representing the units of electrical measure" in Section B, lines 14 to 21, under the heading of "Ampere," it states "as a unit of current the ampere, which is ·1 C.G.S. unit, and is represented sufficiently well for practical purposes by the unvarying current, which when passed through a solution of nitrate of silver in water and in accordance with the specifications contained in Schedule 1 to this Act, deposits silver at the rate of ·001118 gramme per second." What does this mean? It means that they have practically adopted the chemical meter for determining the unit of current. In the Act it says the electro-chemical equivalent is ·001118 for a silver voltameter just the same as 00034 represents the grammes deposited per coulomb in a zinc or ·000305 for a copper voltameter. It is immaterial whether they specify silver, copper, or zinc, the principle is exactly the same, and it does look absurd on the face of it when the unit of current ·1 C.G.S. unit is according to law laid done as above, yet in the same Act a meter on precisely the same principle is limited to the extent of the number of meters in use at the time the law came into force. It may be argued that it is not the principle of the meter that is the objectionable point, but that it is not self-recording, the law, of course, calling for "dials." If any consumer wishes to keep a faithful record of the number of hours he burns his lamps he is at perfect liberty to do so, and if he does so conscientiously and the lamps are of the efficiency they are said to be, I suppose then the bill rendered from the meter reading will coincide exactly to a cent.

Again, it has been claimed by some holding important positions that to be renewing the zincs is practically renewing the meter—that is, supplying a new meter. Did you ever hear of such gross rot? What is the law on this point? It is "that the present number must not be increased, and all new meters must be of the direct-reading type," or words to that effect. The Government has to raise a revenue, that is settled; the gas companies contribute a certain percentage of that revenue, the electric companies are their greatest competitors; therefore we can readily infer that any little obstacle that can be put in the way by such companies will be done, and it is very common property that this Act was the result of the gas companies. May I ask, "Where did the Government get hold of that definition of the ampere, and also the voltameter specification? How are we to determine from this the alternating unit of current?" Has the Government inspector created any better feeling between the companies and the consumer? Do consumers pay their bills with any better grace than before the law came into force? Do customers put any faith in this test? Are there any advantages to be derived from this test? If so, where? The answer to the first three is in the negative, and the fourth in the affirmative, and to the last I will leave it unanswered for the present.

Probably I have digressed from the line of these papers, and in returning the same I wish to again draw your attention to the advantages as enumerated above in the electrolytic meter. Is there another meter in the market that can lay claim to the same?

[It is a pity that the author does not recognise the difference between alternate current and continuous current when drafting his conclusions, as from the body of the paper one would infer that even for alternating currents the Edison meter had advantages. We do not think that this class of contribution tends to advance the character of the institution before which they are read.—Ed. *E. E.*]

THE ELECTRIC LIGHTING OF CALCUTTA.*

The planning of electrical supply for a large city is a somewhat complicated matter. It differs essentially from the drafting of a gas or water scheme in that there exist numerous systems or methods more or less adapted to different-sized areas and varied peculiarities of local circumstance. It is apparent that the object to be attained by the engineer is a supply safe, reliable, and suitable to the public and private requirement at a minimum of current outlay.

The scheme proposed by Messrs. Kilburn and Co. does not in our estimation promise to secure to the city of Calcutta the above-named advantages. From that com pany's public notification dated June 10 we learn that they intend to light an area some 4,4 miles long and 1,6 miles broad "by means of the low-tension continuous-current system. The electricity to be generated at *one station* and stored in secondary batteries at sub-stations, and from thence distributed by means of distributing mains throughout the specified area of supply . . . or by means of such other system as shall be approved of by the Local Government, subject to the regulations and conditions for securing the safety of the public and for ensuring a proper and sufficient supply of energy as the Local Government may from time to time impose." The reference to some "other system" made herein must

* This is an editorial article from the current issue of *Indian Engineering.*

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apply to improvements in electric lighting methods to be discovered in the future, so important as to warrant their adoption in place of Messrs. Kilburn and Co.'s proposed low-tension scheme; for it cannot be that a company, presuming to light a city of the importance of Calcutta, should evidence uncertainty as to which system they intend to adopt when applying to Government for an electric lighting license.

We have thus to discuss the merits of the above-mentioned system, which is apparently to Messrs. Kilburn and Co.'s thinking the best for the purpose. The voltage specified by them demands in the first place attention. As all systems now in general use provide low-tension distribution on service lines, no special merit attaches to the proposal on this account: other systems are equally harmless to the user. It remains to consider the advantage of low tension in the primary or distributing mains. Here it is true that its use guarantees immunity to the unauthorised and mischievous party who meddles with mains, which high tension does not. Beyond this we fail to discover any notable claim in favour of low-tension primary supply to be served from one station over an area of the considerable size here in question. For low-tension means by Board of Trade definition a tension not exceeding 300 volts, and it is well known that distributing tensions of 2,000, 5,000, 10,000, and even 20,000 volts have been successfully and practically employed to the present. We can point to the gigantic Tivoli-Rome, London, and Lauffen-Frankfurt works, among a host of others, in support of this statement.

Now it is apparent that if distribution takes place at a tension of 3,000 instead of 300 volts, the section, and consequently the cost of primary mains, will be enormously reduced, and with it the proportionate quota of repairs, interest, depreciation, and redemption. Apart from this it becomes economically possible by the use of high tension to reduce the total percentage of losses in the mains alone to from 10 to 15 per cent. of the total output; whereas low-tension distribution over an area of the extent in question could scarcely be achieved, commercially considered, with less than 35 to 40 per cent. of corresponding loss. Now, supposing even it could be shown that for this case the cost of low-tension supply would be equal, or nearly equal, to that of high-tension, we maintain that it would still be a mistake to sanction the use of low tension, for the area in question does not represent the whole of the present city of Calcutta. We have on the other side of the river a large station and an industrial district of the first importance which ought certainly not to be overlooked in the planning of any project for the supply of light and power. We have furthermore to keep in view the continual extension of our boundaries; and to establish supply works which can be simply and uniformly extended to meet the calls of every increased demand which the future may hold in store.

In the second place, we have to comment upon the proposed utilisation of electrical storage batteries. The claims put forward with respect to these are numerous. They are said to effect a reduction in the first cost of the generating machinery; as a smaller plant may be worked longer hours and with better economy while charging them. We find, however, that the advantage claimed in this respect is more than balanced, for areas such as the present, by the cost of the storage cells, their location in sub-stations, and the repairs and attendance they require. It has indeed been maintained by those interested in the sale of such apparatus that, for equal output, the total cost of wages and salaries, management, repairs, and maintenance, is less for storage battery than for alternate-current distribution. Statistics of some of the best British practice however, completely refute this assertion. We find by comparison of the records of six important battery stations with six such stations in which high-tension distribution is employed that the above charges average for the latter only 72 per cent. of those of the former description. Apart from this, we should deprecate any extensive employment of storage batteries in their present state of development in circumstances such as we have to deal with in Calcutta. It is sufficiently well known in technical circles that accumulators even in Europe require most skilled, careful, and constant attention to prevent their decay and failure. If that be the case there, it would be so to a considerably increased measure in this country, where the services of skilled hands have, moreover, to be dearly paid for. Though local experience as to storage is not very extensive, so far as it has been brought to our notice, it bears out our above remarks completely; one or two successful installations have to be set against a considerable number of failures.

That the Calcutta Municipality should incur such risk when other more promising, simple, and well-tried methods are at their disposal is not to be anticipated. The high-tension alternating systems have been frequently attacked on the head of the increased outlay for fuel which they demand as compared with storage distribution supply schemes. This objection is without question justified, and it will therefore be well to investigate its comparative importance. We find from statistical reference that per unit delivered we have to anticipate, with British circumstances, a difference of roughly 25 per cent. in coal consumption between alternating and storage supply. As the cost of coal, paid for at 16s. per ton, averages about 20 per cent. of the total maintenance costs of a supply station, these costs to include working expenses, management, depreciation, and redemption, it results that an increase of 25 per cent. on coal alone would result in only 5 per cent. increase in the total current expenditure, or even less at the lower price of coal in Calcutta. Had we not to set against this the higher efficiencies obtainable in the primary circuit and distribution apparatus of high-tension alternating plant, the merit of the extreme and superior simplicity of the latter, and the facility with which it is controlled should commend it to a first place in the estimation of Indian engineers.

That we do not stand alone in our above opinions concerning alternating-current supply is evidenced by the enormous footing it has gained of late years both in Great Britain and on the Continent. With respect to the United Kingdom only we are informed by Dr. J. A. Fleming, F.R.S., in his paper on alternate-current transformers, that "there are at present about 50 alternating-current electric supply stations in the United Kingdom, supplying not less than 1,100,000 8-c p. lamps," corresponding to an expenditure of 54,000 h.p. Apart from the immense value as a lighting agent, however, the alternate current affords the most remarkable facilities for the transmission and distribution of energy in the form of motive force, a matter of the utmost importance in an industrial centre. The difficulty of obtaining sufficient motive power at a low cost for the service of *small* industries is completely overcome by its means; and the electromotors, giving out 400 h.p. to 600 h.p., now in use in Kolomna, Riga, Tokio, and other places prove its practical utility also where very *considerable* forces are concerned. This latter consideration obtains weight also from the widely-discussed proposal of introducing electrical tramway service in place of the apparently unsatisfactory horse traction now in vogue.

In summary of the results of our foregoing discussion we find in favour of alternate-current distribution—including, of course, single and multiphase systems—as compared with the low-tension, single central battery sub-station system, that the alternating distribution is (1) effected with equal safety to the consumer; (2) with less loss in the mains; (3) at a greatly reduced cost of the latter; (4) that it possesses unparalled facilities for increase of output and the supply of larger areas from one central; (5) that the cost of up-keep and management, exclusive of fuel, is lower and the management more simple; (6) that it is more reliable, as the risk incurred by the use of batteries is abolished; (7) that it is most admirably adapted for the transmission and distribution of force.

Against this we have only to set, in favour of the low-tension battery scheme, a slight reduction in coal consumption per unit produced by the generators. With regard to the latter, we would distinctly state that from British statistics we find the total cost of supply per useful unit no higher for alternating stations than for such as make use of storage batteries.

Before concluding our remarks we have to dispose of one more claim in favour of storage battery supply—namely, that the latter is ready to meet demand when generators

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are out of action. This claim might be enforced with reason had we to deal with a private installation of such small demand for night and day current that the generators could not be run continuously with desirable economy. But in every supply station of importance provision is most amply made, and reserves maintained to meet the current demand of every hour during both day and night, and the failure even of a generator unit in action would not as a rule interfere with the regular current supply for more than three to four minutes. In a former issue we have expressed some of our opinions with regard to the description of main conductors we think most adapted for use in Calcutta. Those remarks must be read in the light of our present article, as they are intimately connected with our advocacy of the high-tension alternating-current system on the basis of its superior merits.

The technical aspect of Messrs. Kilburn and Co.'s scheme is unfortunately not the only one from which we must withhold our approval. We think, however, it may safely be left to our local leaders in finance and the sages of the London market to sift the value of the project as a commercial enterprise, with due reference to the public notice of June 10 last and the stipulations contained in the license applied for to Government by the firm in question. No pains has evidently been spared over the concoction of this document, which comprises some 30 half foolscap pages of print; but, in spite of its ample volume, we feel assured that many of its stipulations and omissions would result, were it ever adopted, in disagreement, and loss both to the prospective user and to the speculating investor.

THE SUCCESSFUL HANDLING OF STREET RAILWAYS WITH THE DESPATCHER'S TELEPHONIC SYSTEM.*

BY J. L. M'LEAN, CHIEF DESPATCHER, LOS ANGELES.

Never has the history of the nineteenth century been marked with such wonderful improvements as those which have been introduced in the method of operating street railways throughout the United States during the past five years, principally by electricity and bringing the telephone into active service, electricity proving itself such a phenomenal success from every standpoint that now nearly four-fifths of the street railway mileage of the United States is operated by its use. While the telephone is also used very extensively, and each day adds to the number used by the street railways, yet to use it in connection with the operating department of a street railway system, such as the writer will hereinafter describe in full, will prove itself as big an improvement over the ordinary methods employed as the electric motor surpassed the horse-car. After changing from the "joggy, weather-beaten horse-car," the "greasy, jerky cable," or "blackened steam motor," to the electric motorcar, where an assured and reliable service could be depended upon, the difficulties of knowing how to obtain such requirements from an economical standpoint baffled the minds of managers and superintendents of the various street railway companies of our advanced country, which have undergone such changes and reorganisations, and even at the present day there is not a slower class of people in the country to pick up a good improvement, or even investigate its merits, than the managers of Eastern roads, who expend thousand upon thousands of dollars every year unnecessarily in the operation of their roads where the old-fashioned system of "time-cards" and "large numbers of stations" are used.

There is no reason why the service of an electric or cable railway improperly managed should not be looked upon as being even worse than the horse car, which occasionally does reach its destination on time, even though it may come two-thirds of the way with one set of wheels off the track, while there is every reason in the world why the service of such roads properly managed should surpass anything ever introduced.

A few things which are not only unpleasant to the public and very expensive to the company that are daily experienced in the operation of over half the electric and cable railways throughout the country at this advanced age (and for which we now have a thorough practical and cheap remedy) are the delays and interferences to the traffic, such as an electric car breaking a trolley, breaking an axle, burning out an armature, or becoming disabled in other ways which cannot be repaired while on the road, as well as accidents and jumping the track. Where the ordinary system of running cars on time-cards and by starters is used, the latter, being at the ends of the roads only, are unable to observe any trouble or interference to the traffic that may be going on until they find that the cars have stopped coming, and discover that they are all blocked at some point on the road. As is a natural result, where so much of the company's business interests and welfare are entrusted to the judgment of the trainmen, before it is possible for a person to catch a car going in either direction he is ordinarily compelled to wait the length of time that it requires to make a round trip on such line that is blockaded. Besides the amount of expense attached, as well as the decrease in the daily receipts where several such things have occurred in one day, the service may yet further be impaired and irregular on account of such disabled car standing at some far-out-of-the-way side track, or perhaps in the car shops, leisurely awaiting the orders of the shop foreman. And it is but natural with the remaining cars on the line, which have always been accustomed to running on a time-card and making just so many trips for a day's work, to continue running on such, regardless of the fact that there is a double and unprotected space in the service making its rounds, and that there should be some system, when a car goes into the shops from any cause, whereby the remaining cars could be uniformly spaced apart during the course of such blockade. Then in most places when a car is started from the shops to run in place of some disabled car, nine times out of ten the crew of such car will go to the wrong end of the line on purpose to have as much lay over time as possible before getting into their proper place. With cable cars they are invariably "breaking grips," dies, or shanks, losing a brake shoe, breaking grip lever, or becoming delayed from street obstructions, such as lumber, coal, or stone wagons breaking down across the track, which all consume from five minutes to three-quarters of an hour delay or lost time in the service. Seldom is there a delay of any description on a city railroad but what a double space in the service is caused, and on a cable railway where there is the ordinary service a cable car cannot make up delayed time, but is liable to lose more time owing to the space there is ahead of it, and the time of day, unless it be on a down grade, when the grip can be released and run faster than the cable, only to endanger the lives of passengers as well as the gripman himself. Hence, we have the same results here as from the derailment of an electric car, which is, that a double space in the service is making its rounds, and most generally at a time of day when the traffic is the heaviest and when the service should be at its best. The system and improved method of despatching cars by telephone is composed of an entire private telephone system, the central office of this system being known as the despatcher's office.

Telephones are stationed at the terminus of each line at which conductors on arriving each trip report their car number to the despatcher, and from him obtain their leaving time. In most places the instruments are placed in small canopy-top houses, built especially for this, and are thus protected from all sorts of weather; though they are sometimes placed on poles, in boxes, with lock and key, each conductor being provided with a key. On trunk lines that traverse one end of a city to another, telephones are placed at certain intervals and important points—such as drawbridges and steam road crossings—and are known as emergency 'phones, to report delays, breakdowns, trouble with overhead line or track, or anything that the despatcher should know to successfully operate and maintain an efficient service. The wires leading from all of these 'phones run directly to the despatchers' office, where they are connected on to a neat glass-front switchboard, about 20in. by 12in. by 8in. in size, stationed on top of a neat oak desk, which is about 9ft. long, at which two despatchers can work at the same time when

* From the *Street Railway Review.*

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necessary, and is known as a combination desk and switchboard. The transmitter, adjustable by means of weights and pulleys, also hangs directly in front of him. A system of magnetic and gravity drops works in connection with a signalling system of small incandescent lamps, the latter being placed back of a stencilled number representing each circuit, which when lighted indicates the circuit calling. A set of cam lever switches which the despatcher works with his left hand restores the drop to its normal position, which, when pulled down, also put out the corresponding lamps, and puts him in direct connection with the party calling. He is provided with a large sheet, 21in. by 24in., on which are listed the numbers of all cars in their regular order, under the proper headings of each line. He is thus enabled to despatch two to seven cars per minute, recording the time each one should leave the terminus on his sheet. A glance at this sheet gives him the immediate condition of the entire system and exact location and direction of each car.

Of course, the calls do not come in uniformly, but vary a great deal owing to the number of cars in operation. The space between cars also varies, as does the number of cars in operation, which is governed by the traffic at different hours of the day in most places. The despatcher's duties have been largely increased owing to the many calls that come through the switchboard from the public telephone exchange to the circuit. But by means of a system of push buttons, running to each officer in the building, he is without the slightest exertion enabled to summon any officer to the public 'phone, which is stationed handy to everybody. He also receives reports from the trainmen, of which he makes a daily report to the general superintendent as to the condition of the cars; such as brakes, trolley, motors, brushes, or lights, or anything being out of order that would likely prevent them from making their schedule time. To keep the car from going in the shops, if possible, this is also immediately reported to the proper departments by the despatcher. He also gets a full report from the conductors of all delays which have happened in connection with their cars during the day of two minutes or over, which, at the close of his shift, are forwarded to the general superintendent's office, together with a report of all cars that have been run in the shops, showing name of motorman, cause, time of day, and number of the replaced car.

As I have before stated, the despatcher is in close touch, by means of telephone, with all of the car houses, shops, division and general officers, including the general superintendent, claim agent, surgeon, foreman of overhead line and wrecking departments, in case of any interferences to the traffic or accidents, so that on a moment's notice any member of these departments may be summoned.

In case of blockades at any point, the despatcher, by being able to communicate with both ends of any line, can maintain a certain service during the course of such blockade, as well as prevent the cars from all bunching at any point by lengthening the space between them, sending them out on a larger headway, and, if necessary, he can on a moment's notice order out extra cars or "trippers," as they are called by some, depending altogether on how long the blockade will last and the demands of the traffic at such time.

The watches of all the trainmen are compared from one to three times a day and kept regulated with the large clock in the despatcher's office, which is the standard time of the system, and which governs the movement of all cars. This time is always obtainable at any point where an instrument is stationed for reporting.

The despatcher is held responsible for the movement of each car. All report to him on each trip between 6 a.m. and 12 or midnight from the ends of their respective lines. No time-card whatever is used where this system is employed. The cars are started in the morning from the various houses at a certain time, and are allowed so much time in which to run from the house to the end of the line, where they report to the despatcher, and from him obtain their leaving time from such point. Different schedules of running time between points are employed at different hours of the day, owing to the demands of the traffic. These schedules are regulated by the despatcher. "Extra cars" and "trippers," before leaving the car-houses at different hours of the day, in all cases report to the despatcher, giving him their car number and the line upon which they are to run. In reply he gives them the leaving time and direction to go, as it often occurs that he can despatch them to fill in a double space that may be coming or going in either direction on a line. The moment that a report is received giving notice of a blockade, the despatcher ascertains the number of the car, and a glance at his sheet gives him the direction going; whereupon he immediately begins to lengthen the space between the cars ahead of the delayed one as fast as they report, taking into consideration the nature of the delay and about how long it will continue. In the meantime he may have summoned either the wrecking car or wagon. Then the moment he receives the word that the blockade is raised, another glance at his sheet and the large clock in front of him gives him the exact location of each car, when, as fast as they report, he begins to despatch them from the ends on their regular space.

I claim for the despatcher's system flexibility and quickness in the adjustment of all cars; also that one ordinarily bright man to act in the capacity of a despatcher can do more from the standpoint of the company's interest towards maintaining a service during the course of blockades and interferences with the cars on a half-dozen lines in 15 minutes, than 15 starters and men on the street can do in an hour. For illustration, take a line with 30 cars on, running on a three-minute headway, allowing 90 minutes for the round trip. We will say car No. 1, according to running time, is due to leave terminus "A" at six o'clock; car 2 in order at 6.3; car 3 in its order at 6.6; car 4 in its order at 6.9, but does not arrive until 6.13, being four minutes late, and having in front of it a seven-minute space at a time of day when it is impossible to make up time. Car 5 arrives on time, at 6.13, but is held until 6.17, hence all cars following have a lay over of four minutes at terminus "A," save those which were held an additional minute at terminus "B" to offset the delay at terminus "A" in running time, and thus have the seven-minute space of No. 4 protected by the time he reaches terminus "B." Whereas, under the ordinary system of "time-card" this car would carry the seven-minute space a round trip over the line before catching up to the other cars on a three-minute space.

I therefore claim that street railways can be more successfully handled with "the despatcher's telephone system" than any other method.

The despatcher's system was put into active operation in 1890 on the Denver tramway, operating 100 miles of electric railway. The writer later on successfully installed the system on the City and Suburban Railway of Portland, Ore., operating 55 miles of electric railway, and in a recent letter received from the manager of that company he stated that the system was not only giving them perfect satisfaction, but that they would not attempt to operate their roads again without it.

The writer has just completed the installation of the system on the lines of the Los Angeles Railway, operating 104 miles of electric railway, comprising 11 different lines in the city of Los Angeles, Cal., which is considered one of the finest systems of electric railways on the Pacific Coast.

THE ROASTING OF IRON ORES, WITH THE VIEW TO THEIR MAGNETIC CONCENTRATION.*

BY PROF. H. WEDDING, BESSEMER GOLD MEDALLIST.

Long before iron ores were smelted for pig iron in the blast furnace roasting processes were employed prior to the direct extraction of the metal from the ore, and after the introduction of the blast-furnace process the roasting of iron ores was still retained. As a rule, the roasting is a preliminary to the reduction process. It is only exceptionally or incidentally that it has to effect the purpose of simultaneously eliminating elements, such as sulphur or arsenic, that could detrimentally influence the iron produced. It is only in very recent times that roasting processes have also been employed in order to render iron ores magnetic, so that they can subsequently, by magnetic concen-

* Paper read at the meeting of the Iron and Steel Institute at Bilbao.

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tration, be freed from gangue—that is, from constituents not containing iron, and be enriched in iron.

On considering the composition of the ferruginous constituents of the ores practically employed in the metallurgy of iron, there will be found, as a rule, in the ores supplied by nature, oxides, hydrates, and carbonates of iron: magnetic oxide in magnetite ores; ferric oxide in red hæmatite ores; ferric hydrate in brown hæmatite ores; ferrous carbonate in spathic iron ores, clay iron ores, and carboniferous iron ores. If sulphur compounds occur, which have to be used as iron ores, as, for example, iron bisulphide in iron pyrites, they must always be first converted into ferric oxide (purple ore) before the material can be further utilised in ironworks practice. Again, from the hydrates water must be expelled, and from the carbonates carbon dioxide, before the iron of these ores can be reduced.

The heats of combination of all iron ores show that a reduction to iron cannot occur as long as sulphur, water, and carbon dioxide are still present. It might consequently be assumed that the only object of roasting was the expulsion of sulphur, water, and carbon dioxide, with a view to the reduction of the iron, were it not that the practical facts were in contradiction to this, in that they show that as a matter of fact even more iron ores that contain neither sulphur, water, nor carbon dioxide, but that consist only of magnetic oxide or ferric oxide, can with advantage be subjected to roasting. The object of this is either to facilitate the subsequent reduction by the formation of the most easily reducible oxygen compounds, or to facilitate the reduction by loosening the texture of the iron ores

[Before taking up the question of magnetic roasting, the author considers the question of roasting as a preliminary to reduction. We have, however, omitted this section, as it is not so interesting to our readers.—Ed. *E. E.*]

Roasting Iron Ores for Subsequent Magnetic Treatment.

The farther is the utilisation of the world's store of iron ores carried, the rarer become those ore deposits which, combined with adequate richness, are sufficiently pure for blast-furnace treatment and still much rarer are those which appear adapted for the open-hearth process—that is to say, for the manufacture of ingot iron from pig iron in the reverberatory. The question of the concentration of iron ores is becoming year by year more and more pressing for iron metallurgists. The prosperity of a country is dependent on its iron industry, but largely, too, on the iron ores it uses being mined in the country itself. Rich and pure iron ores still exist, it is true, in adequate quantity, but they are confined to a few places in different countries. Our excursion brings us to Spain, the country which provides all the iron-producing countries of Europe with ores of this kind. Sweden is not less rich in ores such as these, but how long will these sources of supply be available? The iron metallurgist finds it day by day a more pressing matter to enrich and improve unsuitable iron ores, and for this purpose magnetic concentration occupies the foremost place. Of the different compounds of iron with oxygen, practically only the two oxides Fe_6O_8 and Fe_6O_7 are adequately magnetic. Ferric oxide is nearly non-magnetic, and ferrous oxide cannot be produced in practice. On the other hand, the ferric oxide in red hæmitite, or in dried brown iron ore, may be readily rendered magnetic by roasting—that is to say, may be readily converted into the magnetic oxide. Three possibilities exist in this direction. When the atmosphere during roasting is oxidising in character—that is to say, when air is admitted—either the ferric oxide is converted into the magnetic sub-oxide Fe_6O_7 or Fe_6O_8, or else by the accurate roasting of carbonates a magnetic oxide is produced, or from the oxide, Fe_6O_9, by a reducing roasting a magnetic lower oxide is obtained.

Whether any one of these methods will be profitable is mainly a question of cost. The reduction is certainly rendered more difficult, the fuel consumption during reduction becoming greater, and the magnetic roasting with the subsequent treatment also in itself entails additional expense. Probably, therefore, in most cases a preliminary preparation of the ores for the blast-furnace treatment will be out of the question. On the other hand, a pure ore, despite great cost, may in many cases prove useful in the open-hearth process—that is to say, in the oxidising fining for ingot iron in a reverberatory provided with heat-regenerating chambers, by means of which, that is, molten pig iron is converted into molten malleable iron. One sees, therefore, that the question as to what is to be done to convert non-magnetic ores into magnetic ores is by no means one that should be overlooked, but that it is rather of great importance.

Phillips has published an account relating to the magnetisation of the red iron ores of Birmingham, Alabama, with a view to the necessary further concentration by the magnetic process. If the observations of this writer are taken into consideration jointly with the results obtained at Allevard, in France, which I have described, one obtains from these perhaps the only cases in practice in which iron ores that are non-magnetic by nature are prepared by roasting for a subsequent magnetic treatment. The first case relates to the roasting of ferric oxide, Fe_6O_9, and the second to the roasting of the carbonate, $FeCO_3$, for conversion into the magnetic oxide.

Magnetisation of the Various Iron Ores.

1. *Magnetites.*—Magnetites are of themselves magnetic, and do not therefore need to be first rendered magnetic before they can be submitted to a magnetic concentration. Nevertheless, roasting may be necessary for such an ore, partly for the purposes of facilitating its further reduction in size for the magnetic treatment by rendering it more easy to break down, and partly for the purpose of eliminating the sulphides it may contain, such as iron or copper pyrites or zinc blende. Magnetites only lose very slowly their natural magnetic properties on roasting, no matter whether the roasting is oxidising or reducing in character. Only when they are maintained for a very long time at a medium red heat and with access of air will the magnetic oxide pass gradually into ferric oxide and the ores cease to be magnetic. On this point Phillips has made detailed investigation. He made a large series of experiments and heated portions of native magnetite in a strongly-oxidising flame for 30 minutes without influencing their magnetic character. At a dull red heat in an oxidising flame some pieces lost their magnetic power, but regained it when raised to higher temperatures. This regaining of the magnetic properties is a fact which was noted long ago by H. Rose, who showed that on heating an iron oxide in a porcelain furnace, the oxide partly lost its oxygen and became magnetic. In a similar manner native magnetite can absorb oxygen and lose its magnetic properties, but regain these when heated to a still higher temperature—the first time through absorption, and the second through loss of oxygen. In this connection it may be pointed out that the artificially-prepared magnetite does not behave so favourably as the native mineral, but loses and regains its magnetic character more readily.

2. *Spathic Iron Ores.*—From the carbonates, by suitable roasting, the magnetic iron oxide can be obtained direct. By roasting in a neutral atmophere the "ignition" magnetic oxide Fe_6O_7 is obtained, and by roasting in a moderately oxidising atmosphere, the magnetic oxide Fe_6O_8. If, however, the carbon dioxide is once eliminated, both these magnetic oxides pass readily under the action of the oxygen of the air into the non-magnetic ferric oxide Fe_6O_9. If, therefore, it is desired to produce the magnetic oxide, the whole success depends on roasting with exclusion of air, or, if this is impossible, on reducing the air access to a minimum. The ferric oxide which is produced when there is free access of air is, however, at higher temperatures, just as decomposable again into the magnetic oxide and oxygen, as has already been referred to in connection with the native magnetites. It is possible, therefore, without endangering the magnetic character of the product, to roast spathic carbonates at temperatures as high as may be necessary to eliminate as far as possible the sulphur occurring in the spathic ores as iron and copper pyrites, zinc blende, etc. On the other hand, this necessitates a larger consumption of fuel than would be necessary if the spathic ores were only to be converted at a low temperature into the condition of the magnetic oxide. For the preparation of magnetic oxide from the spathic carbonate, no reducing roasting atmosphere is consequently necessary.

3. *Red Hæmatites.* — Magnetic oxide can be prepared from the ferric oxide of red hæmatites in two different ways: (1) By heating strongly in the absence of air. One atom of oxygen separates off in this way, and, indeed, by properly firing two oxygen atoms may be eliminated—$Fe_6O_9 = Fe_6O_8 + O = Fe_6O_7 + 2O$. For this reduction of ferric oxide, as Phillips has shown, a relatively very high temperature is necessary, at which, if the red hæmatite contains a quarzose gangue, slag may readily form. In any case it is difficult, at the high temperatures at which this separation of oxygen takes place, to avoid a sintering, or even it may be fusion of the gangue with the ferric oxide, and the formation of an iron silicate. (2) The second method of preparing magnetic oxide from red hæmatites depends on the roasting of the ore under the action of reducing gases, of which at low temperatures hydrogen and at higher temperatures carbon monoxide are most suitable in their action. To be certain, therefore, it is best to employ in the roasting a mixture of both these gases—that is to say, to roast with ordinary water gas. The readiness with which the reduction takes place depends in both cases, with red hæmatites, largely on their more or less dense texture. Many red hæmatites are so excessively dense that just as little reduction takes place with as without the use of reducing gases, even when the ignition is long continued. On the other hand, blast-furnace practice shows that there is no red hæmatite which, given adequate time, is able to resist the reducing action of carbon monoxide, even completely down to the metallic state, and this reduction must of necessity be preceded by a transition through the different stages of the magnetic oxides of both kinds.

4. *Brown Iron Ores.*—Before the ferric oxide of the hydrated iron oxides can be reduced the water must first be eliminated. The residue then behaves as a red hæmatite would, but the reduction proceeds far more readily under the influence of reducing gases, owing to the more porous character of the ore

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after the elimination of the water. Laboratory experiments have shown me that even from the iron oxides of the dehydrated brown iron ores, magnetic oxide may be prepared both by strongly heating with exclusion of air and by heating gently in reducing gases. Here, too, it is a question dependent on the character of the gangue contained in the ore as to which method is best to be employed. If one has to deal with ores containing no quarzose gangue, high temperatures may be used; if the ores contain intermingled sulphides, this must be employed, or in the first place the treatment must be oxidising, and then reducing in character. On the whole, for brown iron ores the method in which use is made of reducing gases at a low temperatures is most advantageous on economic grounds, owing to the saving of fuel.

5. *Pyritic Ores.*—Pyritic ores, before a reduction can take place, must first always be robbed of their sulphur contents, or at least mainly so. As in any case pyrites is subjected to an oxidising roasting for the purpose of obtaining sulphur dioxide from its sulphur contents, the residue is in practice always ferric oxide, and this ferric oxide behaves exactly as that of red hæmatite, except that it is a little more difficult to reduce, owing, perhaps, to the presence of some residual sulphur. As is well known, iron pyrites is only then used as an iron ore when it contains copper, or perhaps, too, zinc. In addition to the chlorides of the metals resulting from the oxidising roasting of the pyrites in admixture with salt, ferric oxide also results. The former are extracted by leaching with water, and the ferric oxide remains behind in a practically pure state. Purple ore is pure enough for magnetic separation to be unnecessary.

Size of the Ores to be Roasted to Magnetic Oxide.

The size of the ore pieces to be roasted to magnetic oxide is not unimportant. Before all things it is necessary, in order to obtain a good result, to have the pieces that are to be roasted as nearly as possible of the same size. It may be taken as a rule that the magnetisation takes place the more readily the more the ore is in the form of small but solid pieces which do not crumble up or fly into bits on roasting, since the gas can then readily pass through the interspaces, and the relatively small ore particles are rapidly converted into magnetie oxide right through their mass. A much larger size of the ore particles is disadvantageous, as for their conversion into the magnetic oxide too long a time is necessary, and since it is then uncertain whether this magnetisation has gone right through to the centres of these ore lumps. Phillips has very rightly pointed out, in opposition to the observations of Barton, that the magnetisation always takes place from the outside inwards, and never from the inside outwards.

Pulverulent or very small ore particles are excessively difficult to magnetise, since the passage of the gases through the small interstices is rendered very difficult, and the gases usually form small ways or channels, from which the conversion then begins. It is therefore very difficult to magnetise ores for magnetic preparation which have already been broken down very small, or are pulverulent—slimes, that is. All such experiments which have been made, as, for instance, those at Allevard, have led to results which have not been altogether satisfactory, as the size of the pieces to be magnetised was much too small. More important than the actual size of the pieces is the necessity for having them under all circumstances of a similar size, and one cannot therefore pay too great attention to ensure, by twice passing through screens before the magnetising roasting takes place, that all the ore pieces to be roasted have been brought to one and the same size.

Furnaces.

The requirements for the roasting of different kinds of ores, and especially of different ore-sizes, necessitate naturally the construction of different kinds of furnaces. Lump ores are always best roasted in shaft furnaces, in which an easy and regular passage of the ore through furnaces of circular section is obtained. The section of the furnace should widen slightly from the throat downwards in view of the gradual heating of the ores and their expansion. Inversely this leads also to a more regular upward passage of the furnace gases through the ore. It is therefore a question of causing the ore to pass through two different stages, first heating them, and then reducing them if they are oxidised, provided, of course, that they are red or brown hæmatites. This must be effected by using gas in two ways, partly as fuel and partly as the reducing agent. As Phillips has observed in his description of the roasting of red hæmatites, the gas for heating purposes is best introduced into a combustion-chamber in which it is burnt around the furnace, so that only the flame enters the furnace. It need hardly be mentioned that gases cannot be burnt without the presence of a not inconsiderable excess of air, and attention has therefore to be given to seeing that in the heating of the ore an oxidation is as far as may be avoided. Only in the case of red hæmatites which are to be reduced by the splitting-off of oxygen at a high temperature is a temperature to be employed which may be as high as is possible of attainment, and in this case it may be a matter of indifference whether an excess of oxygen is present or whether this is absent. In the case of spathic ores the only thing that is necessary is heating in the absence of air, with no subsequent oxidation, although here, too, the treatment with reducing gases can only be advantageous in character. The reducing gas, whether ordinary producer or (and better) water gas, must then be passed into the heated ore from a lower level, and caution is necessary to ensure that no air can enter. The openings which are to be employed for the withdrawal of the roasted ores from the furnaces must therefore be capable of being closed perfectly airtight during the roasting, and the brickwork, too, must be built so as to withstand the passage of air through it. To be able, however, to readily withdraw the ore, the reducing gas must be passed into the furnace at a level somewhat above that of the withdrawal doors. One obtains in this way the advantage that the gas in its upward passage at the same time cools down the hot ore, with the result that this arrives at the withdrawal openings in an almost cold condition. The space between the entry of the hot burnt gases and those used for the reduction ought never to be small, as is often the case in Swedish calciners. One of the principal conditions for properly roasting iron ores into the magnetic state is the keeping of a right temperature in every part of the furnace. Since the Le Chatelier pyrometer is made in the form described by the author (*Stahl und Eisen*, 1896, September), all difficulty in controlling the temperature is obviated, and the instrument may unhesitatingly be relied upon for this purpose.

In the case of pulverulent or fine ores, the use of shaft furnaces is not advisable, and it is better in such a case to employ zig-zag furnaces, such as were used at Allevard, or channel furnaces with inclined beds. Still, care should as far as possible be taken never to have to deal with such fine ore, but rather with ore of a coarser character.

Concentration of the Magnetised Ore.

The magnetised ores, after the roasting, must be submitted to concentration, which may in the first instance be mechanical in character, to separate from each other the ore particles of different sizes, and then magnetic, or it may be magnetic from the very commencement. This must be entirely dependent on the character of the ore as regards admixture of gangue and iron oxides. The finer is the state into which the ore is brought for magnetic separation, the more satisfactory will the progress of that separation naturally be, and the better will be the yield. The fine state of the ore has, however, in spite of this, various drawbacks. In the first place, as has been mentioned above, the magnetisation is, as a rule, by no means regular, and in the second, such finely divided ores can only be added with advantage in quite small quantities to the blast-furnace charge, former experience in this direction placing this maximum at 12 per cent. All methods, too, of converting this fine ore again into larger lumps are too expensive to be, at least, generally, commercially satisfactory. If, therefore, the ore is to be used in blast-furnace practice such very small ore must, as far as possible, be avoided, and the size should be kept at about that of hens' eggs. On the other hand, small and even pulverulent ore may very well be utilised in the open hearth, and it has for this field of operations, I think, a very wide scope indeed, for the scrap which is now necessary for the conversion of the pig iron into ingot metal in the open-hearth process is becoming year by year more difficult to obtain and more expensive to purchase, and it might very readily be entirely replaced by oxides. If the ores powder up readily on charging into the bath of pig iron, they may be enclosed in cases of sheet iron or paper (cartridges).

Very few ores are of themselves pure enough for the open-hearth process, and they cannot either be converted into an adequately pure form by mechanical concentration, so that there is scarcely any other way of purifying them which could prove itself commercially economical except the method of magnetic concentration, which, if the ores are not magnetic, must be preceded by a magnetic roasting.

PROPOSED SCHEME FOR ELECTRIC LIGHTING OF ABERDEEN HARBOUR.

We are indebted to the *Aberdeen Journal* for the following abstract of the report on the above subject, which is about to be presented to the Corporation:

Mr. Blackman, borough electrical engineer, and Mr. R. Gordon Nicol, C.E., harbour engineer, have, as instructed, prepared the report on the most suitable system of electric mains, lamps, and fittings for lighting the quays, and for the supply of electric power at Aberdeen Harbour. The quays, which it is proposed should now be lighted by electricity—viz., Waterloo, Regent, Trinity, Market, Provost Jamieson's, and Provost Blaikie's Quays—have an aggregate length of 2,400 yards, and vary in width from 20 to 48 yards. They are lighted at present by gas lamps of about 25 nominal candle-power,

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spaced about 48 yards apart in two rows, one row on the edge of the foot pavement, being provided and lighted by the Town Council, while the other row is placed on the street, about six yards from the edge of the quays, and is provided and lighted by the Harbour Commissioners. At important places on the pavement and quays Bray's lamps of about 80 c.p. have been erected.

It is proposed that one row of electric lamps should be erected about the middle of the quays, of such a power, height, and distance apart as to provide sufficient light over the whole area of the quays, provision being at the same time made for the supply of portable arc or incandescent lamps to shipping at the quays when such lamps are desired. To secure this they are of opinion that arc lamps to carry 10 amperes of current and give about 2,000 nominal candle-power should be provided—elevated on standards to a height of 25ft. above the level of the street, and placed at distances of about 40 yards apart, lengthwise of the quays. They would be coupled up in groups of four lamps in a series, across the outside wires from the electricity works; the groups being combined in pairs in such a way that the switching out of one group would extinguish each alternate lamp over a length of 320 yards of quay.

The mains for the supply of electricity to the lamps would extend in a complete circuit round the docks, passing underneath the entrances to Victoria Dock, and have a feeder crossing the dock to a point in the mains at the south end of Regent Bridge. From the foot of Commerce-street along Regent Quay and Trinity Quay, where private consumers may be expected, the mains would consist of bare copper strip, laid in a concrete culvert in the foot pavement, with lead-covered cables in iron casings at the street crossings—branch conductors of armoured cable being taken across the quays, underground, to each group of lamps. From the corner of Guild-street, along Market Quay, Provost Jamieson's Quay, Provost Blaikie's Quay, under the dock entrances, and along Waterloo Quay to the foot of Commerce-street, they would consist of armoured cable buried directly in a trench in the ground in the line of the lamps.

The connections for the portable lamps to be hired out to shipping would require to be fitted up at the edge of the quays, as the traffic on the line of rails next the coping would otherwise be subject to interruption. In consideration of this they are of opinion that the cast-iron bollards on the edge of the quays could be made to contain the switches, connecting gear, and current meters, and would be most suitable for that purpose, the lamp wires being connected to the face of each bollard, and laid on board where required. The branch conductors from the mains would be passed underground and up into the bollard heads, the switches being operated and the meters read through a door in the side of the bollard. As they will require to be specially designed for this purpose, it would be advisable at present to provide such bollards on the new wall at Regent Quay only, or wherever new bollards are required, as they could then be made suitable at little additional cost.

The beacon lights for shipping traffic at tide times would be arc lamps carrying 30 amperes of current and giving about 6,000 nominal candle-power. They would be placed at the dock entrance and at Regent Bridge on lattice pillars, 80ft. high, and supplied with electricity from the lighting mains.

To provide a supply of electricity for motive purposes they are of opinion that the current should not be taken from the same mains as supply the arc lamps, as the intermittent demands upon the current by motors if worked at night would be certain to lead to fluctuations in the light. The power circuit would therefore be entirely separate from the lighting circuit and would consist wholly of armoured cable buried in the same trench as the lighting mains, where these are of armoured cable. It would commence at the foot of Commerce-street, and pass round the quays to the point of starting. From the power mains branch conductors would be taken underground to convenient points, where connections could be made by flexible wires to electric cranes and whips, and to the machinery of the new swing bridge, if this type of motive power should be decided upon to operate the bridge. The quantity of current used by each group of lamps would be measured by a meter placed on the base of one of the lamp-posts; there would also be a meter in each bollard head, while the current used by motors would be measured by a meter at each motor. The foregoing report is based on the assumption that the necessary electricity would be generated at the Corporation electricity works, the whole of the mains and branch conductors laid and maintained by the Town Council, and the lamps and motors erected and maintained by the Harbour Commissioners.

They estimate the cost of the works described above as follows: By the Town Council—mains and branch conductors for lighting circuit, including culverts and trenching, £5,000; ditto for power circuit, £1,750—£6,750. By the Harbour Commissioners—sixty 10-ampere lamps on quays, with posts, complete, £1,620; eight 10-ampere lamps in sheds, £96; six portable ditto, for shipping, with conductors, £120; three 30-ampere beacon lights, with pillars, complete, £750—£2,586. Total cost, £9,336.

A NEW TYPE OF CABLE ARMOURING.

We have received particulars of a new departure in the armouring of electric light cables introduced by Messrs. W. T. Glover and Co. The illustration below will explain the general design of this new cable, which is practically one with a bare return. The armouring is used as the return circuit, and consists of two parts, the iron or steel segments forming the mechanical protection and the copper wires the conductors.

It will be observed that the cables are completely sheathed with the iron or steel segments forming the lock armour, and the round wires of copper practically act as the keys locking the segments together. The surface of the lock armour is smooth and continuous and enables the cable to be nicely finished. It at the same time protects the cable from being pierced by picks or other sharp instruments which are liable to force their way through a round wire armour. The advantages of the copper wires in the armour are manifest.

If ordinary iron or steel wire armour is used for the purpose of conveying energy, and particularly in cables of large size, the weight of such metal required to accommodate the current is so great that the cables are both costly and unwieldy. Still, there is no reason why the iron armouring should not act partly as the return, and thus save a portion of the weight of copper required. The combination of the two metals in this armour is therefore a happy one, as the makers gain in three directions—*i.e.*, mechanical strength, conductivity, and cost of copper. Cables are often required having an earthed or bare return for use in coal mines and for shiplighting, etc., but we should imagine that to prevent electrolytic action between the two metals in the armour the outer serving of insulation will be adhered to.

We understand that Messrs. W. T. Glover and Co. will manufacture this type from the smallest to the largest size required for lighting purposes, the quality being guaranteed, and that the length in which such cables can be supplied is practically unlimited. Samples of this new cable—to give it its full name, Glover's patent high-conductivity lock armour—can be seen at the firm's London office, 39, Victoria-street, and at Salford, Manchester.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Spa (Belgium)—The Burgomaster and Echevins of Spa invite propositions for undertaking the public lighting, either electrically or by acetylene. The date fixed is September 15. No further information is given in the official advertisement.

Hamburg.—Tenders will be received on September 19 for an incandescent and arc lighting installation for the stages at Brookthurhafen. Application should be made to the Finanz Deputation, and a local guarantee will be required.

Berlin.—The construction of an iron bridge at Gitschiner-und-Skalitzer-street in connection with the electric tramway is open for tender. Application is to the Königl. Regierungs und Baurathes Bureau, Markgrafenstrasse 94, Berlin, and the date is September 28.

Villefranche-Lauragais (France).—The Municipality of Villefranche-Lauragais (Haute-Garonne) have invited competitive plans for a public water supply and electric lighting. Prizes of 1,000fr., 500fr., and 200fr. are offered, under the usual conditions, and schemes must be sent to the Mairie by October 10.

Odessa.—The Municipal Authorities have decided to offer for tender the electric lighting of part of the suburbs and the new prison. No date is given, and application must be made to the Municipal Delegation at Odessa, but certain particulars can be obtained at the Ministry of Commerce (bureau de renseignments commerciaux), Paris, rue de Varenne 80.

Cologne.—Tenders are required by the Municipal Authorities for the construction and working of electric tramways in the city of Cologne to an aggregate length of 20·3 kilometres (12½ miles). Specifications, plans, and particulars are obtainable for 10 marks (10s.) from der Registrateur B, des Oberbürgermeisteramt, Köln, Germany, and tenders must be in by November 6.

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Amsterdam.—Up to September 12 the Consul-General of the South African Republic (Transvaal) will receive tenders for the supply of insulators with supports. The address is at Doelenstraat 8, Amsterdam. Specifications will be procured on demand by Mr. F. J. Belinfante, late A. D. Schinkel, Paveljoensgracht, The Hague, at the price of 1sh.

Madras.—Tenders are invited for the lighting by electricity of Government House, Madras, including the banqueting-hall and aide-de-camps' bungalow, and also for the lighting of Government House, Guindy, including the military secretary's bungalow. For particulars application must be made to the consulting architect to the Government, Chepank, Madras. Tenders will be opened on November 11, 1896.

Voghera (Italy).—In view of the expiration of their contract with the local gas company in 1898, the municipal authorities of Voghera are desirous of receiving during the present year propositions for the lighting of the town either by the electric light or a mixed system of gas and electricity. The population is 16,000. Application should be made to L'Administrazione Comunale, Voghera, who will give all particulars necessary.

Mayaguez (Puerto Rico).—The Secretary of State for Foreign Affairs has been informed by H.M. Ambassador at Madrid that the Spanish Government have invited tenders for the construction and working of a telephone system in Mayagüez, Puerto Rico. The date fixed for the consideration of tenders is October 8, and such particulars as have been received may be inspected at the Commercial Department of the Foreign Office between the hours of 11 and 6 daily.

Oldham.—The Electric Light Committee invite tenders for the various works required in the extension and alterations of the buildings of the electric light station in Gas-street, Oldham. Specifications and drawings can be seen, and schedules of quantities obtained, on application to Mr. Arthur Andrew, Gas and Water Offices, Oldham. A charge of £1. 1s. will be made for the schedule of quantities, which will be returned on receipt of a bona fide tender. Tenders to be sent in by September 15.

Brussels.—Tenders will shortly be wanted (the date is not yet fixed) for installing the electric light at the Arlon Railway Station, including the offices and works. Particulars will be obtainable at the Brussels Bourse. La Société national des chemins de fer vicinaux will receive tenders up to October 28 for the conversion of about 14½ miles of tramway in the suburbs of Charleroi into electric lines on the overhead system. Particulars are obtainable, price 1fr., from the office of the Société, Brussels, rue de la Science 26.

Edinburgh.—The Lord Provost, Magistrates, and Council are prepared to receive tenders for the wiring of the Burgh Assessments Office, High-street. Specification, forms of tender, and plans of the building can be obtained at the office of the resident electrical engineer, 5, Dewar-place, Edinburgh, on deposit of two guineas, which deposit will be returned on receipt of a bona fide tenders. Tenders must be sent to the town clerk, Mr. Thomas Hunter, City Chambers, Edinburgh, not later than Tuesday, September 22.

Hull.—Pending the decision of the Town Council as to the leasing of the tramways or the working of them by the Corporation, tenders are invited for a license to temporarily work and use the tramways for one year from October 15, 1896, upon the terms and conditions embodied in the draft of an agreement, which can be obtained by application to Mr. R. Hill Dawe, town clerk, Town Hall, Hull. Tenders, stating the amount of rent offered, must be delivered at the Town Clerk's Office, by 10 a.m. on September 21, in sealed envelopes, endorsed "Tender for Temporary Working of Tramways."

Cadiz.—The Secretary of State for Foreign Affairs has received dispatches from her Majesty's Consul at Cadiz, stating that preliminary tenders for a supply of electric lighting apparatus for the illumination, on the most approved modern plan, of private houses, etc., in the town of Cadiz are invited by the "Sociedad Co-operativa Gaditana de Fabricacion de Gas." It appears that the tenders should be sent in by September 15 to the above-named company, whose offices are San José, 25, 27, and 29, Cadiz. Firms wishing to obtain the contract for the supply of plant are advised by the Consul to send representatives to treat personally with the company. Such additional particulars as have reached her Majesty's Government on the subject may be viewed at the Commercial Department of the Foreign Office, any day between the hours of 11 a.m. and 6 p.m.

Morley.—The Electric Lighting Committee of the borough of Morley are prepared to receive tenders for the supply and erection of the following plant. (The whole bound up in one specification; price £2. 2s., returnable on receipt of a bona fide tender): Section A—Boiler-house plant: Lancashire boilers and fittings, feed pump, etc. Section B—Engine-house plant: steam alternators and exciters, motor alternator, accumulators, steam and exhaust pipes, valves, etc Section C—switchboard and instruments. Section D—overhead crane. Section E—underground work: cables and stoneware culverts. Section F—transformers and switchboards. Section G—arc lamps, posts, and accessories. Section H—meters. Tenderers are at liberty to tender for either section, but not for part of a section. The ground plans of plant and specification, with terms and conditions of tenders and contract, may be obtained at the offices of Mr. Robert Hammond, the consulting engineer to the Corporation, Ormond House, Great Trinity-lane, London, E.C., on and after Wednesday, September 16, on payment of £2. 2s. for each copy, which sum will be refunded on the return of the specification, filled up with a bona fide tender. Tenders, sealed and marked "Tender for Electric Lighting," must be addressed to the town clerk, Mr. R. Borrough Hopkins, at the Town Hall, Morley (Yorks), and be delivered on or before Wednesday, October 14.

RESULTS OF TENDERS.

Dundee.—The Gas Committee of the Town Council have accepted the offer of the India Rubber, Gutta Percha, and Telegraph Works Company, Limited, Silvertown, to lay down india-rubber-covered electric cables in the Overgate, Wellgate, and Whitehall-street districts. The price is £718. 1s. 9d.

Glasgow.—Messrs William Ramsay and Co, electrical engineers, 11, Jamaica-street, have received the contract to fit the electric light on an extensive scale into the Liberal Club, Buchanan-street. The installation includes lighting of halls, dining-room, reading-room, card-room, billiard-room, smoke-room, staircases, etc.

Salford.—The Guardians received two tenders for the maintenance and repair of the telephones at the clerk's office and workhouse—one from Mr. J. G. Riddell, King-street, Manchester, who offered to do the work for £9 per year; and another from Mr. John Faulkner, Great Ducie street, Manchester, who quoted £9. 10s. per annum. The tender of Mr. Faulkner was accepted.

Shoreditch.—The Vestry have accepted the following tenders: The Electrical and General Engineering Company for wiring underground conveniences at £39. 7s 6d.; Messrs. Hemingway for Contract No. 6 at £442 (Messrs. Laing, Wharton, and Down having withdrawn their tender in consequence of the omission of an item of £100); and Messrs. Macfarlane and Co, for the supply of combined arc and incandescent lamp posts at £527.

Dortmund.—The figures of the tenders for the supply of engines, boilers, and dynamos for the town electricity works have been published, but not the name of the firm to whom the contract is to be given. A large number of German firms tendered, but as the tenderers specify the efficiency, consumption, etc., they propose, there is, strictly speaking, no "lowest tender," except in the case of the dynamos, for which the lowest tenders are those of the Helios Actien Gesellschaft.

BUSINESS NOTES.

Holywell.—The new line of telegraph from Holywell to Halkin was opened last week.

Whitefield (Gloucester).—It is proposed to establish telephonic communication in the town.

Direct Spanish Telegraph Company.—For the month of August the receipts were £2,038.

Sleaford.—In all probability the Kesteven and Grantham District Asylum will be lighted by electricity.

Willenhall.—The Council are going to introduce electric fire-calls and other improvements at the fire station at a cost of £224.

Oswestry.—The Town Council have decided to purchase an automatic electric motor pump for sewage work at a cost of about £250.

Belfast.—The Corporation have accepted the tender of Messrs. William Coates and Son for the fitting up of an installation of electric light in the gasworks.

Change of Address.—Messrs. Calvert and Co., electrical engineers, have removed from 24, Exchange-buildings, Manchester, to larger premises at 4, St. Mary-street.

Wigan.—The minutes of the Gas and Electric Light Committee were adopted at the meeting of the Town Council after some lengthy criticisms on the part of Mr. Fyans.

Rotherhithe.—The Vestry have accepted the tender of the Brush Electrical Engineering Company, Limited, amounting to £196. 12s. 6d., for the provision of electric wires to the new town hall.

Electric Club, Limited.—This Company has been formed, with a capital of £1,000 in £1 shares. Its object is to acquire and carry on the Electric Club, as now carried on at 44, King William-street, E.C.

Personal.—Mr. John C. Snell, the King's-road electric station engineer, has resigned his appointment under the St. Pancras Vestry, having been appointed borough electrical engineer of Sunderland.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending September 6 amounted to £1,212, as compared with £1,324 in the corresponding week of the previous year, being a decrease of £112.

Auto-Motor Express Company, Limited.—This Company, with a capital of £2,000 in £1 shares, has been formed to carry on the business of commission agents, shippers, carriers, etc., in all or any of their respective branches.

Dundee.—In the Town Council estimates for the current year, which were adopted at the last meeting, lighting is set down at £6,435, in place of £6,495, a saving of £60 being expected in the electric lighting of the High-street.

Boston.—The Town Council have approved the action of the Paving and Lighting Committee in authorising the expenditure of £25 in obtaining the opinion of an expert on the question of providing an electric light installation.

Carnarvon.—The Town Council have granted permission to the National Telephone Company to put up telephone poles in Mill-lane, Hole-in-the-Wall-street, and the Corporation yard, subject to the conditions of their usual agreements.

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Johannesburg.—It is stated that the Government has sanctioned a scheme for providing the Rand with a comprehensive scheme of electric tramways for the purpose of connecting the city with some of the populous suburbs along the main reef.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ending September 4 were £2,374. 0s. 2d., compared with £2,123. 2s. 10d. for the corresponding period of last year, being an increase of £250. 17s. 4d.

The French Congo.—The French Government is understood to have decided to establish a telegraph system in its Congo territories, and an engineer is to be sent out to make the necessary arrangements for setting up the line and organising the service.

Glasgow.—The Corporation Tramway Committee have resolved to recommend that the tramway manager and engineer should be sent to America to make further enquiries about electric motors. The Corporation have purchased the Govan and Ibrox Tramway for £7,500.

Epsom.—The Urban District Council have decided to engage Mr. Hawtayne, electrical engineer, to report upon the question of electric lighting for Epsom, with a view to obtaining from the Board of Trade a provisional order authorising the Council to light their district by electricity.

Price-List.—We have received from Mr. Arthur Cort, of 277, Camberwell New-road, London, his price list of red, grey, or black hard or flexible fibre in sheets, tubes, rods, washers, valves, etc., for electrical, mechanical, railways, tramways, carriage builders, and general engineering purposes.

City and South London Railway.—The returns for the week ended September 6 were £848, compared with £839 for the corresponding period of last year, being an increase of £9. The total receipts for the half-year 1896 were £9,181, compared with £8,508 last year, being an increase of £673.

Newport (I.W.).—The Town Council have decided to agree with the National Telephone Company to pay £9. 10s. per annum for a term of seven years for their providing and maintaining a telephone service from the waterworks to the town hall and sewerage works, independent of the exchange.

Portraits.—Under the title of "Men and Women of the Century," a collection of portraits by Mr. R. Lehmann is to be published by Geo. Bell and Sons. The facsimile work is to be done by the Swan Electric Engraving Company, and the collection includes the portraits of several engineers and men of science.

Westminster.—The system of electric lighting at the official residence of the First Lord of the Treasury in Downing-street is being extended. The electric light has been for some time in use in some of the principal apartments, but during the present recess the system will be made general throughout the establishment.

Blackpool.—The Council have made an alteration in the scale of charges, to take place from January 1, 1897, to the effect that all consumers over 10s. per quarter are to be charged 8d. per unit for an average consumption of one hour per day, and that for all current over and above the average only 2d. per unit will be charged.

Droitwich.—The question of adopting the electric light has started in the town. At the last meeting of the Town Council some opposition was made to the proposal to spend £3,000 on an extension of the gasworks on the ground of the possible adoption of electric lighting. The little cloud no bigger than a man's hand has appeared on the horizon.

Shoeburyness.—At a meeting of the Urban District Council a letter was received from Messrs. Alfred Dickenson and Co. saying that they had clients who were prepared to construct an electric tramway from Southend to Shoeburyness, and they asked if the Council would approve of it. It was agreed to reply that the Council would favourably consider the scheme.

Leatherhead.—Mr. Dearle has given notice to move at the next meeting of the Urban District Council, "That a memorial be presented by this Council to the Board of Trade applying for a provisional order under the Electric Lighting Act, 1882, to authorise this Council to supply electricity for any public or private purpose within the area of the urban district of Leatherhead."

Bristol.—Highbury Chapel and Redland Park Church are among the most recent of the many places of worship which have adopted the electric light. Additional machinery—part of the extension scheme in connection with which sanction to borrow £75,000 was recently obtained—will shortly be put down, and the committee will then be able to supply current for 34,000 incandescent lamps.

Outing.—The employés of the Incandescent Electric Lamp Company, Limited, of Hammersmith, had their annual outing on Saturday last. The party, numbering over 150, accompanied by the manager, Mr. C. J. Robertson, proceeded to Hastings by an early train. Dinner was served at the Central Hall, and after a most enjoyable day the party returned to town, reaching London shortly before 10 o'clock.

Dewsbury.—At the meeting of the Town Council Mr. W. Townsend asked if the Corporation electrical works were improving in regard to income, or whether, if there was a debit, it was gradually lessening. The Mayor said the statement of the electrician was that there was a debit for the half-year of £139, but the annual statement was expected to show that they were on the right side. It was agreed to extend the mains to Wilton-street.

Appointment Vacant.—The Electric Lighting Committee of the borough of Huddersfield are prepared to receive applications for the situation of working mechanical engineer in the electric supply station. Salary £2. 10s. per week. Applications must be sent to Mr. F. C. Lloyd, town clerk, at the Town Hall, not later than Monday, September 21, endorsed "Working Mechanical Engineer." Further particulars of the appointment appear in an advertisement in another column.

Girston.—Mr. Medhurst having reported upon the subject of supplying the district with electricity in conjunction with a refuse destructor, the District Council have decided that the scheme suggested by Mr. Medhurst be adopted, that the law clerk shall take steps to acquire an order from the Board of Trade and apply to the Local Government Board for sanction to borrow £25,000 to carry out the works, and also advertise for a site for the refuse destructor and works to supply electricity.

Tonbridge.—The Electric Lighting Committee have been empowered to obtain a report from a competent electrical engineer as to the requirements of the town at a cost not exceeding 20 guineas. At the meeting of the gas company, a considerable discussion took place as to the desirability of the company applying for a provisional order to enable them to supply electricity within their area, but the matter was allowed to remain over until it was seen what steps the Urban District Council take.

Yarmouth.—This year's statement of Corporation income and expenditure is considerably increased by the figures of the electric lighting department. The amount expended on the electricity works since they were begun to December 31 was £20,232. 0s. 10d. The receipts for the same period totalled up to £18,707. 12s., showing a difference of £1,524. 8s 10d. against the borough. For the year ended March 25 the revenue amounted to £1,914. 17s. 1d., and expenditure, without interest or sinking fund, £1,765. 9s. 7d.

Millet's Patent Motor Wheel and Cycle Company, Limited.—This Company has been started, with a capital of £100,000, to carry on business as manufacturers of and dealers in motors of every description, cycles, omnibuses, carts, wagons, vans, vehicles, ships, boats, launches, flying machines, and carriages of all kinds, and also all apparatus and implements and things for use in business, pleasure, or recreation, or any component parts thereof or accessories thereto, also as electricians, mechanical engineers, etc.

Colwyn Bay.—A letter was read at the meeting of the Colwyn Bay and Colwyn Urban District Council from Messrs. Dickinson and Co., Birmingham, as to the opinion of the Council with reference to the construction of an electric tramway between Colwyn Bay and Llandudno. Mr. George Bevan moved, the Chairman seconded, and it was carried, that the Council are in favour of such a project, and calling attention to the fact that the power of supplying electricity in the district is now vested in the Council.

Liverpool.—Mr. Charles Rettie of Geraint-street, writes to the *Liverpool Mercury* asking why the Corporation do not reduce the price of electricity to 4d. all round. Since the Corporation have taken over the electric supply company's undertaking, both the supply and contract department, they have reduced the price per unit from 7½d. to 7d., and for large consumers taking over 1,000 units to 4d., and the meter rent has been, or will be, reduced from 2s. per month to 1s.; but Mr. Rettie thinks everybody ought to be treated alike

Warrington.—At the meeting of the Town Council Councillor Heaton, in moving the confirmation of the minutes of the Gas Committee, remarked that it would be seen that the chairman had been requested to bring the question of electric lighting before the General Purposes Committee, and he had no doubt he would do so. Councillor Bennett said he cordially congratulated the committee upon their prompt acceptance of the suggestion he made at a recent meeting with regard to electric lighting. He hoped that before very long they would have a very desirable improvement in Warrington in that respect.

Presentation.—On Monday evening, the 31st ult., an interesting gathering took place at Wolverhampton, the occasion being a presentation to Mr. William Bulloch, C.A., accountant to the Electric Construction Company, in honour of his approaching wedding. The present consisted of a handsome silver tea service and salver, and in a few well-chosen remarks, Mr. A. B. Blackburn, manager, referred to the good feeling existing among the officials of the company, and asked Mr. Bulloch to accept of the gift with the best wishes of the subscribers, which included the technical and commercial staff both at Wolverhampton and London.

Birkenhead.—The Finance Committee of the Corporation have considered the subject of the supply of electricity in the borough. It is expected that the work of laying wires and erecting electric light generating stations will be completed by the middle of the month, when the current will be available for consumers in the central districts of that town, where at present mains have only been laid. It has been arranged to introduce the light as soon as possible into the town hall. The standard of energy in the distributing mains has been fixed at 230 volts, and consumers will be charged according to the actual quantity of energy supplied after the rate of 6d. for every unit.

Shoreditch.—The Lighting Committee of the Vestry having considered the three tenders for wiring underground conveniences recommended that the tender of the Electrical and General Engineering Company, at £39. 7s. 6d., should be accepted. This was agreed to. Messrs. Laing, Wharton, and Down having omitted the cost of mains to the motors in their tender of £428 9s. 6d. under Contract 6, wished to withdraw unless a variation in the specification was allowed. As this would mean £100 extra, it was decided to accept the next lowest tender, of Messrs. Hemingway at £442. Three tenders were sent in for the supply of combined arc and incandescent lamp posts, and that of Messrs. Macfarlane, at £527, was accepted.

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Niagara.—The first long-distance transmission of electrical current from Niagara Falls is to be started early in November, the current being conveyed to Buffalo, a distance of 20 miles, where it will be used for traction and other purposes. The voltage is to be 11,000, and transformers are being completed at either end at Niagara. The current is 2,200 volts, but it will be increased, while at the Buffalo end it will be stepped down from 11,000 to 100 volts. Part will be used for traction work at 550 volts The first instalment of power to be transmitted is 1,000 h p., and this will be used on the tramways of Buffalo, but the pole line for the conductors has a capacity for 40,000 h.p.

Chester.—The laying of the electric light cables is going on satisfactorily. The cable has already been put down on both sides of Watergate-street and Bridge-street and one side of Eastgate-street. The next street to be dealt with is Northgate-street. The main distribution-box will be fixed near the market, and we hear it is intended, after the first installation, to lay a feeder as far as the boundary of the compulsory area, which extends to the top of St. John-street. The lighting station is rapidly nearing completion. The whole of the roof is on the engine-house, boiler-houses, battery-room, and offices. Two of Messrs. Babcock and Wilcox's boilers have already been put in their places. The chimney has reached half its proposed height, which will be 140ft

Aberdeen.—A memorial signed by all the traders in the portion of George-street in which the electric mains are laid has been presented to the Town Council requesting that the thoroughfare be lighted by means of electric lamps. The city is now in direct communication by telephone with practically the whole United Kingdom, excepting Inverness and northward. The trunk wires all over Scotland will, after December 19, be wrought entirely by the State, although they have actually been its property since April 4. The portion of the trunk wire from Aberdeen to Glasgow is the old trunk line, but from Glasgow to London a special line has been constructed by Government. The wires are of copper, and weigh 800lb. to the mile, and they are worked on the loop principle.

New Swindon.—The following letter from Messrs. Eastlake, Limited, electrical engineers, of Parliament street, Westminster, S.W., was read at the Urban District Council meeting : "Swindon New Town Electric Lighting Order.—Dear Sir,—With reference to the above, we are prepared to make a proposal to your Council to take over the provisional order they have obtained for a term of years. We are further prepared to enter into an arrangement with the Council for the destruction of the town refuse should this be desired. We should be obliged if you will place this communication before your Council, and inform us whether they are disposed to entertain such a proposal, when we should be glad to enter fully into the matter with them " The letter was referred to the Electrical Lighting Committee.

Sale.—Letters were read at the Urban Council meeting from Messrs. Andrew and Butterworth respecting the proposed electric tramway from Stretford, *viâ* Sale, to Peel Causeway, and also from the Manchester Carriage Company, asking the opinion and assistance of the Council for a tramway to and from the same place to be worked by horses or electricity. A long discussion followed, and it was decided to acknowledge the receipt of the letters, and to reply that the Council were disposed to sanction the tramway consistent with the interest of the ratepayers being safeguarded. The matter was re-referred to a special committee of the above Council which was to meet and receive deputations from the promoters of both schemes, and after considering the matter to report to the next Council.

Bury.—The Electric Lighting Committee have resolved not to grant the application of Messrs. Siemens for an extension of the time for the completion of their contract, and notice has been given to them that unless the work is completed in the time stated in the contract the penalty clause will be enforced. The distributing mains are to be extended from Clough-street up Stanley-street and Water-street to the bottom of Walmersley-road. The tender of Chamberlain and Hookham for meters has been accepted. The Mayor, the Chairman, Alderman Parks, and Councillor Collinge have been appointed a sub-committee to make proper arrangements for a formal opening of the electric light installation. It is proposed to light the large lamp in the Market-place and certain other lamps with electricity.

Tunbridge Wells.—The vicar of St. Mark's, the Rev. Dr. Townsend, writes as follows : "When I first advocated the use of the electric light in St. Mark's one of the advantages suggested was economy ; this forecast seems likely to hold good. I have seen the electric light account for the quarter ending June 29, 1896, and I find that it is considerably less than the gas account for the same quarter in 1895. The electric light stands at £4. 12s., while the gas cost us about £5. 12s. This is a large percentage of difference, and if it holds good in the other quarters a decided saving of expense is likely to ensue." It may be added that not only is the church better lighted, but the congregation enjoy the comfort of a purer atmosphere at the services, so that these advantages must be added to the economy.

Croydon.—The Corporation on Monday night brought its new electric lighting works into use for the first time the municipal buildings, with the clock tower, being illuminated by electricity. The town hall contains 1,000 lights of 16 c.p. each. The experiment was an unqualified success. It is expected that electric lighting in the borough will be general by the end of next year. The works are rapidly approaching completion. The flues at present are connected with a temporary iron shaft, and it was, we understand, contemplated to retain this temporary shaft until the destructor scheme had developed, and then raise a permanent shaft which might answer for the two. It has, however, now been decided to put up a separate shaft for these works. The concrete bottom has been laid in, and the flues will be extended as this is raised.

Company Receipts in America.—The Edison Electric Illuminating Company of Brooklyn report gross earnings for July of 59,018dol., an increase of 9,918dol. as compared with the same month of last year, and net 24 138dol., an increase of 5,432dol For the seven months ended July 31 the gross earnings were 462,430dol., an increase of 161,608dol. as compared with corresponding period of last year, and net 205,274dol., an increase of 78,719dol. The Edison Electric Illuminating Company of New York report gross earnings for July of 156 891dol., an increase of 21,197dol. as compared with the same month of last year, and net 67,270dol., an increase of 8,736dol. For the seven months ended July 31 the gross earnings were 1,262,795dol, an increase of 111,154dol. as compared with the corresponding period of last year, and net 611,803dol., an increase of 62,267dol.

Crewe.—At a meeting of the Town Council the Health Committee submitted a report advising that the isolation hospital should be lighted by electric light. It was pointed out that 28 beds in the hospital were apportioned in the various wards on the basis of 2,000 cubic feet to each patient, assuming that gas was the illuminant used ; but with electric lighting substituted for gas, this amount might very well be reduced to 1,200 cubic feet, in which case the accommodation would be increased from 28 to 45 or 52 beds, thus obviating the necessity of future extension for many years. The difference in the cost would be an increase of £17. 18s. 6d. per annum, this including the repayments of principal and interest on a loan for the provision of the necessary apparatus, including engine, dynamo, and installation of 104 lights. The recommendation of the committee was adopted.

Rangoon.—The plant for the electric lighting of the Jubilee Hall arrived the last week in July. The machinery and fittings are from Crompton and Co., London and Chelmsford. The plant consists of two of Crompton's compound dynamos, driven by separate engines of Marshall and Co.'s latest designs. Each dynamo will run one-half of the light, thus providing against a total extinction of the lights. The electroliers and all fittings are handsome and substantial, and are from the firm of Edison and Swan. London stage-lighting apparatus of the most recent design, as adopted in the London theatres, has been supplied by Crompton and Co. The management of the work will be undertaken by Mr. D. Coath, Crompton and Co.'s agent in Rangoon, who gives his own services and provides the necessary skilled labour for fitting up the installation free of charge as his contribution to the Jubilee Hall.

Dudley.—A sub-committee appointed to consider the whole question of public lighting have resolved as follows : "Your committee are unanimously of opinion that a provisional order should be applied for by the Town Council enabling them to supply electricity for lighting and other borough purposes as soon as practicable, and they believe, especially considering the advantageous terms upon which capital can now be raised, the installation can be made a commercial success. They feel, however, that the responsibility of taking the necessary steps to carry out this recommendation, costing as it is estimated to do £25,000 or thereabouts, should be taken by the Council and shared by every member thereof, and they therefore advise that the Council should themselves appoint a committee, not exceeding 10 in number, who should not be shareholders in the Dudley Gas Company, and who have, where possible, some practical acquaintance with electric work and machinery, such committee to consider the subject fully and report definitely to the Council at their October meeting."

Hammersmith.—The Vestry have received 130 applications for the position of resident engineer in connection with the electric lighting works. The applications have been referred to the Electric Lighting Committee with instructions to select six to appear before the Vestry. The Electric Lighting Committee reported as follows : "That having received a letter from Messrs. Leslie and Co., stating that they were unable to complete their contract in the time specified if the glazed fireclay is used for the plinth to the chimney shaft, as they found it would be impossible to get this made under three months, and suggesting that the substitution of Bramley Fall stone for the glazed firebrick, which would effect a saving of 1s. 4d. per cube foot (about £60), we have authorised the substitution of Bramley Fall stone for the glazed fireclay in the moulded plinth course. The difference to be adjusted on completion. That we have given instructions for certain necessary statutory notices to be served upon the Postmaster-General, the London County Council, and the railway, tramway, gas, water, and telephone companies, in accordance with the provisions of the electric lighting order."

Babcock and Wilcox, Limited.—The report of the directors for the year ending June 30, to be submitted to the general meeting to-day (Friday), states that the accounts show that the profit during the year amounts to £72,446. From this amount £20,000 has been written off purchase of business account, leaving £52,446, which, with £4,831 brought forward, makes a balance of £57,277. From this sum is deducted the interim dividend for the half-year to December 31 at the rate of 6 per cent. per annum on the preference shares and 5 per cent. for the first six months of the financial year on the ordinary shares, amounting to £10,000, leaving £47,277, from which the directors recommend that the following dividends be paid for the half-year ended June 30—namely, at the rate of 6 per cent. per annum on the preference shares (subject to income tax), absorbing £3,000, and 10 per cent,

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for the second half-year on the ordinary shares (free of income tax), taking £14,000; placing to a reserve fund £25,000, and leaving a balance of £5,277 to be carried forward. Owing to increase of business, it has been found necessary to provide larger works, and for this purpose ground has been bought at Renfrew, where suitable works are being erected which, it is expected, will be completed within the next two months.

Salford.—The Electric Light Sub-Committee are preparing an approximate estimate of the cost of providing an electric light installation for the town hall, and also an estimate of the difference in cost of lighting by the electric current and by gas for one year. At a meeting of the Parliamentary and Public Trusts Committee a letter was read with reference to an application by the Manchester Carriage and Tramways Company for a double line of tramways in Eccles New-road to Weaste, and a further letter from Messrs. Brett, Hamilton, and Tarbolton, on behalf of the company, with reference to the construction of tramlines in Cross-lane and Trafford-road, in which they suggested that the company might apply for the requisite powers and allow the Corporation to carry out the work. The committee resolved that whilst thinking it desirable to accede to the request of the tramways company, at the same time they deemed it wise to make application for the necessary powers themselves, and recommended the Council to instruct the town clerk to make application to Parliament during the ensuing session for a provisional order empowering the Council to carry out the necessary works. The following were appointed a sub-committee to wait upon the directors of the tramways company and arrange all matters of detail: the Mayor, Aldermen Jenkins B. Robinson, W. Robinson, and Councillor Ollier.

Folkestone.—At the Town Council meeting Mr. Moat read the preliminary report of Dr. Hopkinson upon the draft agreement between Mr. Hopkins and the Corporation The general tenor of it was that the terms proposed were fair and reasonable on both sides, and, in fact, rather advantageous to the town, as compared with other towns, but he asked for further information as to the area, etc., to be lighted. Councillor Pursey said he did not think they were really in a position to deal with the report, as it was a document which would want a good deal of overhauling. He was not at all satisfied with the way in which it had been submitted to Dr. Hopkinson. He always thought that the draft agreement was to be first submitted to the Corporation, but it had not been. In the first place, there was no provision as to the system of electric lighting, and the machinery that was to be put in, and as they, as a corporation, were to have the right to purchase at a stated period, they ought to know what they would have to purchase. There were many other really important points that ought to be introduced. He moved that it be submitted to a committee, consisting of Councillors Tolputt, Penfold, Baker, himself, Councillor Vaughan, and the Mayor. Councillor Harrison seconded. Councillor Jones moved as an amendment that it be a committee of the whole Corporation, and Mr. Pursey assenting to this, it was carried.

Cheltenham.—The question of the proposed electric tramway has again been before the Street and Highway Committee, and they have resolved that the route be from the Midland Station, along Queen's-road, Lansdown-place, Bayshill-road, St. George's-parade, St. George's-place, St. James's-parade, St. James's-square, Ambrose-street, St. George's-street, St. Margaret's-road to North-place, North street to gas offices, Albion-street to Portland-street, Portland-street to Evesham House, thence to Prestbury-road, and along Prestbury-road to the borough boundary; also that the gauge of the tramlines be the standard gauge of 4ft. 8½in. At a meeting of the Lighting Committee the borough surveyor submitted plans of two alternative arrangements for lighting the Promenade and High street with arc lamps, one requiring 56 lamps and the other 62; also a design for suspending the lamps in the Promenade by means of pairs of pillars, 37ft. high, of steel tube with ornamental cast-iron base, and a chain or wire rope at any desired height between 16ft. and 22ft., the cost of which would be about £25 per lamp; and that 11 lamps would be required in the Promenade if ordinary lighting was adopted. The committee resolved that for a commencement the number of arc lamps for the Promenade and High-street be 58, and that the borough surveyor be instructed to obtain a pattern of the pillars for the Promenade.

Burnley.—At a meeting of the Gas and Electric Lighting Committee the electrical engineer reported the result of enquiries made by him with respect to extending the electric main in Yorkshire-street. It was resolved that, subject to the approval of the Council, the main in Yorkshire-street be extended to Plumbe-street, at an estimated cost of £200, and that, in the event of the trustees of the Fulledge Chapel undertaking to use the electric light in connection with their schools and chapel, the electrical engineer be authorised to further extend the main to Fulledge Chapel, at an additional cost of £100. The price of electrical energy for public purposes was reduced to 3d. per unit. At the meeting of the Town Council Alderman Parkinson said he thought the committee were too hard upon applicants before consenting to extend their mains. He believed they required a guarantee of a turnover representing 20 per cent. of the total outlay. He thought that was too much to ask. Alderman Sutcliffe said it was the outlay on the cable only, not the works. The Mayor did not think it would be wise to deviate from the system upon which they had hitherto acted. The salvation of their works, in making them a paying concern, had been the limiting of their cables to a somewhat confined area. If they were to branch out indiscriminately in any direction and to have, perhaps, a very few customers topping a cable which they might lay, the profit would soon turn into a loss.

Bradford.—At the meeting of the Town Council, Mr. W. C. Dixon (chairman of the Gas and Electricity Supply Committee) moved the adoption of the minutes of that committee. The minutes included resolutions for the extension of electricity cables up Little Horton-lane, Church-bank, and Barkerend-road, at a total cost of £850; the reduction of the charge for electricity supplied for motive power from 3½d. to 2½d. per unit from January 1 next; and advancing the salary of Mr. W. Jones, mechanical engineer in the electricity department, from £143 to £170. Mr. Dixon said the electricity department was making as rapid progress as the Corporation could desire. The three-wire system had been completed practically throughout the borough. The buildings were as far advanced as had been expected, and one of the new engines was already being put into its place. The two new boilers were in Bradford waiting to be delivered, and would be put in position as soon as possible. There was a trade profit in connection with the electricity department for the half-year of £3,578, as against £3,176 last year, or 4·24 per cent., against 4·73. There was a net profit, after deducting interest and sinking fund, of £1,007, against £986 last year, or 1·19 per cent, against 1·47 per cent. The capital outlay amounted to £84,351, against £67,112 last year. He had to report a substantial increase of 35,954 Board of Trade units. The total net revenue from the gas, chemical, and electricity works to be handed over to the Finance Committee for the reduction of the rates was £8,557, equal to a saving of 4d. in the pound for the half-year. The minutes were adopted. The question of applying for power to construct tramways to Great Horton and Bolton road was deferred for further consideration.

Eccles.—The report of the proceedings of the Electric Lighting Committee of the Town Council has recently been issued. It contains a letter from the Local Government Board in which they state that, after consulting the report made by Mr. Willcocks, who held an enquiry into the application of the Council to borrow £20,000 for the electric lighting of the borough, "they are advised that the scheme is not altogether satisfactory, and in particular that, in a compact district like Eccles, a continuous current with a low pressure should be used, and not an alternating current with high pressure and transformers as proposed, inasmuch as under the latter system accumulators cannot be used, and heavy expense would be incurred in keeping the dynamos running all day. The proposal of the Town Council to avoid this expense by cutting off electricity for eight hours every day would result in a very serious inconvenience to those who may wish to use electricity for other than lighting purposes. Further, the Board are advised that the land proposed as the site for the generating station is too small for the purpose, and that the stipulation in the covenant on the land as to the carrying on of any business which was, or could, and might be deemed a public nuisance or a private annoyance or inconvenience to the neighbourhood might very probably lead to litigation after the works had been set up. Moreover, the Board learns that there is considerable opposition to the scheme, and they understand that there is not now a majority of the Town Council themselves in favour of it. Under these circumstances the Board are not prepared to comply with the application of the Council." An offer from Edmundson's, Limited, to take over and carry out the electric lighting order obtained by the late Local Board has been referred to the Council to deal with.

Bury St. Edmunds.—At the Town Council meeting Alderman Lake again asked the Town Clerk (Mr. C. E. Salmon) as to whether it was probable the Local Government Board would sanction the formation of a private company, having for its object the indemnity of the Council for the period of 20 years against loss from supplying the borough with the electric light, the company to receive all profits which might be made during the same period. The Town Clerk remarked that the question was of such a novel character that he thought it best to look into the matter before giving an answer. He had communicated with his parliamentary agent (Mr. E. E. Baker), who, in answering from 22, Great George-street, Westminster, wrote: "I certainly never heard of such a proposal before as that suggested in your letter, and very much doubt whether the Local Government Board would sanction it, but as the Corporation are applying for an electric lighting order, the Board of Trade might be asked to insert clauses to carry out the proposal, and if they agreed probably the Local Government Board would also agree. The scheme would be quite unworkable unless the Corporation have an absolutely free hand with regard to the working of the undertaking as to price to be charged." Alderman Lake felt confident that, could such an arrangement have been made as that which Alderman Gough and himself were prepared to stand by, the ratepayers would have complained when they found the profits were going into the pockets of guarantors. Alderman Gough anticipated that ultimately there would be a handsome profit from the adoption of the electric light, although it might not be realised during the first few years. Personally he regretted his offer to become a guarantor could not be accepted.

Catalogues.—We have received from Mr. A. H. Avery, of Tenterden, his catalogue of electrical apparatus and appliances. Many of the articles in the catalogue have been designed to suit the wants of amateurs, and there is at least one speciality—namely, static electromotors. Of these it says "there is no complete circuit through them, and they consequently take no current, working on the principle of mutual repulsion." It is to be presumed that by no current is meant so little current as not to be easily measurable in the ordinary way. It is understood that Mr. Avery suggests that these motors are more than mere toys, and may "find a useful application in such establishments as paper factories, where at times great trouble is experienced

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from static discharges," since "by the use of a static motor these discharges can be transformed into mechanical energy and used for ventilating purposes, etc." If anyone would like to try to run a small fan with one of these, it can be done for from 15s. to 30s, according to size. Another of Mr. Avery's special articles is a pole-finding paper. Mr. Avery says this is extremely sensitive and cannot give inaccurate results We have not had the pleasure of trying it, but if that is so it is decidedly superior to some specimens we have seen of German manufacture, with which it would be quite possible for the ignorant amateur to make mistakes. Mr. Avery claims a high quality for all his goods.—We have also received the 1896 price list of the Newton Electrical Works at Taunton. The special production of the works is, of course, the "Taunton" dynamo. This is listed for 100 volts and 135 volts on the first two pages. Direct-coupled engines and dynamos follow, and then come motors, switches, and transformers (alternating and continuous current). There are excellent illustrations, including one of the switchboard supplied to the Bristol Corporation station, and diagrams and descriptions relating to the fixing of motors with their starting switches and regulating and reversing boxes.—We also have to acknowledge the receipt of a bound electrical catalogue from Mr. G. Braulik, 218, Upper Thames-street, a review of which will appear next week.

Hastings.—The Roads Committee reported at the meeting of the Town Council that they had received a communication from the secretary of the Hastings and St. Leonards-on-Sea Electric Light Company, Limited, stating that the company's reasons for placing the proposed transformer-pit under the public pavement opposite the Claremont Library (the plans for which were, on the committee's recommendation, disapproved at the last Council meeting, the site for the proposed pit being in their opinion an unsuitable one) were that their mains ran past the spot, and that if the pit were placed on the other side of the road their mains would have to be run across the road to the transformer, and then back again to their present position, which would entail extra expense and cause inconvenience by opening the road. The committee, under the circumstances, now recommended that the plan be approved subject to the work being carried out to the satisfaction of the borough engineer, and to the company giving the usual undertaking not to remove the cover of the pit except between the hours of 10 p.m. and 9 a.m, unless in case of actual emergency. The Roads Committee had also received notice from the company of their intention (*a*) to carry a high-tension concentric $^{7}/_{16}$ cable from an existing box on the east side of the junction of London-road with Norman road, to a point opposite 76, Norman-road; (*b*) to carry a pair of $^{7}/_{16}$ low-tension cables from a point westward of the St. Leonards Mechanics' Institution premises to the point opposite 76, Norman-road aforesaid; and (*c*) to place a cast-iron box, 2ft. by 1ft. 6in., with pavement frame and cover in the pavement in connection with the said mains, in accordance with a plan submitted, and stating that the cables would be run in 2¼in. pipes, laid 18in. under the pavement, and 18in. from the kerb. The committee recommended that this plan be approved, subject to the works being carried out to the satisfaction of the borough engineer, to the company giving the usual undertaking not to remove the cover of the box except between the hours of 10 p.m. and 9 a.m., unless in case of actual emergency, and to the mains being laid at a depth of not less than 30in. at the point where the same cross from the north to the south side of the road opposite the St. Leonards Mechanics' Institution premises. The recommendations were adopted.

Blackburn.—A meeting of the shareholders of the Blackburn Corporation Tramways Company, Limited, has been held to consider a letter from the town clerk of Blackburn with regard to the adoption of electric traction. The letter was to the effect that the Corporation had recently authorised an application for further capital for largely extending their electric lighting works, and in the course of the next year or two probably an additional expenditure of £15,000 would be incurred. The letter further asked that the company would say now whether they would require electricity, and also recommended to the company the adoption of the overhead system. The chairman, in dealing with the two-horse sections of the line—viz., the Preston New-road and Witton lines—directed the attention of the shareholders to the circulars which had been sent to them, showing the comparison of cost between electric and horse power traction on the two sections mentioned. The cost per mile for the 93,892 miles run on the horse sections was 5·95d., whilst it had been calculated that electric traction would cost 3·0d. per mile for the same number of miles, or if increased to 160,000 miles per year, 2½d. per mile. The latter distance, however, they would not be able to reach for many years to come. The Corporation would, if the company so desired, maintain the overhead line for £100 a year. As to the actual working on other lines, repairs and renewals of motors working under cars for 180 000 miles were calculated to cost £150 a year. He (the chairman) had had the opinions of two electrical experts on the subject, and one of them stated that he would contract to do the work for the amount named. An important consideration in favour of electricity was the fact that an electric car would carry 48 passengers, compared to 32 per horse car, which would prove a sure source of income. After considerable discussion, a resolution was passed by a large majority, agreeing to electric power being adopted on the Preston New-road and Witton sections, provided that suitable terms could be made with the Corporation for the supply of the same, the terms to be satisfactory to the Board. The minutes of the Gas Committee, which were adopted at the Town Council meeting, stated that the electrical engineer had reported that in consequence of the extension of the electric lighting installation, it was now necessary to appoint another assistant electrical engineer and also another engine and dynamo attendant, and that it had been resolved that it be an instruction to the town clerk to advertise for an assistant electrical engineer at a salary of £125 per annum, and to submit the applications received to the next meeting of this committee; also that the electrical engineer be authorised to engage an engine and dynamo attendant at the same rate of wages as are paid to the present one.

Colchester.—Colonel Ord Hasted, R.E., one of the Local Government Board inspectors, has held an enquiry in reference to the proposal of the Corporation to borrow £15,000 for purposes of electric lighting. The Town Clerk said he had particulars of the voting during the history of the whole matter which had led up to the application, so that the inspector would see that if there were any opposition it had only arisen recently and in a particular manner. The Bill received the Royal assent on June 9, 1893, the order slightly predating it. The area over which the Bill made the extension of electric lighting compulsory was North-hill, Head-street, and High-street from the top of North-hill to the end of St. Nicholas-street. The Corporation proposed to do rather more than that. There had been no proposal for a company, owing probably to the stringent regulations with which the Corporation hampered the possible formation. There was a proposal by Messrs. Christie to undertake the works on certain terms out of which they considered they could make a fair profit, but the committee considered that the works should be under the control of the authority. The Borough Surveyor produced and explained the plans for the electric lighting station. The buildings were plain, but substantial Mr Massey, the engineer appointed by the Electric Light Committee, gave details as to the machinery, and the cost, which had been ascertained from the actual tenders, and was not a mere estimate. The system it was proposed to employ was the low-tension three-wire system, worked with a current of from 225 to 240 volts. Provision was made for increasing the normal capacity for an hour. The engines, which would be three in number, each being 180 h.p., would couple direct on to the dynamos. The station was rather larger than the present requirements necessitated, in order to provide for extensions. They were providing machinery for 4,000 lights, but the switchboard and buildings were provided for a larger number. Street-lighting could only in the early stage be undertaken at a loss, and the Corporation had decided to drop it for the present, but it could be taken up at any time. To do street-lighting the machinery would have to be added to. The mains were capable of taking more current than it was at present proposed to use, in order to provide for future extensions. The feeders were laid down on such a system that all gas explosions owing to their presence would be impossible. They were providing mains for 4,360 yards of streets. Tenders were obtained for carrying out the work (with the exception of the buildings) from four of the best firms in England, and after most careful consideration it had been decided to place the order provisionally in the hands of the Electric Construction Corporation, of Wolverhampton, whose estimate the inspector had before him. The £15 000 includes the cost of buildings £3 000, land £600, and the remainder is for electric plant. The cost of laying the mains is included.

Lynn.—The minutes of the Urban Sanitary Committee, which were adopted at the last meeting of the Town Council, stated that the following communication and other subsequent letters relating thereto from Messrs. J. McLaren and S. L. Skevens with reference to lighting the borough by electricity had been received: "To the Mayor and Corporation of the Borough of King's Lynn.—Whereas it has been decided by the Corporation of the borough of King's Lynn to apply for powers to enable them to light the town by electricity, we, the undersigned, respectfully beg to submit for your consideration a scheme for carrying the same into effect. It will be understood that the plan we desire to bring under your notice will be considered only in the event of your determining, on pecuniary or other grounds, not to proceed with the work directly through the medium of your corporate powers. We are fully assured that the introduction of electricity on a large scale, such as is proposed, would be most beneficial to the traders and public generally, and would be largely employed by them both as an illuminant and motive power. Our plan broadly and generally described would be to form a company with a capital of, say, £———, the said company to take over and exercise, on lease or otherwise, the powers vested in the Corporation, the company to be in the position of lessee of the Corporation. The Corporation would not be called upon to guarantee or be responsible for any portion of the capital, and would have the option of purchase on the expiration of the lease granted by the Corporation to the proposed company. The work would be carried out under the superintendence of a duly qualified electrical engineer, Mr. J. McLaren, resident engineer at Sandringham, who is prepared to produce plans, specifications, and estimates, the same to be submitted to the Corporation for their approval and assent. We also respectfully beg to suggest that as soon as the Corporation shall have obtained the necessary powers the matter should be thoroughly investigated and a decision arrived at as to the best course of procedure, in order that the public may enjoy at as early a period as possible the advantages of the new illuminant. The erection of the necessary works and the laying of such an installation would necessarily take some months to complete, and all should be in perfect readiness for turning on the current into the street lamps on the expiration of the contract with the gas company. We believe the above scheme broadly and generally described will

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commend itself to the majority of the inhabitants of this borough, and would materially assist the Corporation in their efforts to successfully introduce electric lighting. We should require of the Corporation that they grant us such rights and privileges as would ensure the successful carrying out of the scheme, and secure to the shareholders the profits arising from the same according to the terms agreed upon.—J. McLaren, S. L. Skevens." The borough surveyor has been instructed to make enquiries and obtain information from other towns where electric lighting has been introduced and report thereon at a future meeting; in the meantime Messrs McLaren and Skevens have been informed that the subject of their letter is under consideration.

PROVISIONAL PATENTS, 1896.

August 31.

19207. Improvements in starting speed-regulating, reversing, stopping, and steering mechanism for mechanically propelled vehicles. Ernest John Clubbe, Alfred William Southey, and the Electric Motive Power Company, Limited, 55, Chancery-lane, London.

19218. Manufacture or production of chemical products by electrolysis. Emil Joseph Constam and Arthur von Hansen, 46, Lincoln's-inn-fields, London.

September 1.

19290. Improvements in or relating to electrical furnaces. Alfred Julius Boult, 111, Hatton-garden, London. (Octave Patin, France.)

19301. Improvements in storage batteries. Albert Preiss, 55, Chancery-lane, London.

19303. Improvements in electromagnets. Theodore McKenna, 17, Basinghall-street, London. (Electric Selector and Signal Company, United States) (Complete specification.)

19304. Improvements in electric selectors and adaptions thereof and in transmitters therefor. Theodore McKenna, 17, Basinghall-street, London. (Electric Selector and Signal Company, United States.) (Complete specification.)

19305. Improvements in electrical selecting instruments. Theodore McKenna, 17, Basinghall-street, London. (John Mowe Drysdale, United States.) (Complete specification.)

19308. Improvements in utilising the residual products obtained in the working of certain kinds of voltaic batteries. William Walker, jun., Frank Richard Wilkins, Jabez Lones, and Joseph Lones, 7, Staple-inn, London.

19316. Improvements in electric lamps. Louis Andrews Jackson and Acme Electric Lamp Company, 53, Chancery-lane, London.

September 2.

19396. A new or improved combined electric lamp and walking-stick. Joseph David Lawrence, 33, Chancery-lane, London.

19399. Improvements connected with the electrical coating of tubes, rods, and the like, and apparatus therefor. William Stepney Rawson, 21, Greycoat-gardens, London.

19415. Improvements in or connected with electric railways. Frederick Carleton Esmond, Norfolk House, Norfolk-street, London.

September 3.

19455. Improvements in automatic switches and safeguards for electric traction systems. Silvanus Phillips Thompson and Miles Walker Morland, Chislett road, West Hampstead, London.

19456. An electric traction system. Silvanus Phillips Thompson and Miles Walker Morland, Chislett-road, West Hampstead, London. (Complete specification.)

19469. A means of surrounding electric or other lights with a vessel or lining of glass or other material containing liquids. Edward John Macready, 39, Hampden-street, Higher Tranmere, Cheshire.

19501. Improvements in electric light conduits Bernard Mervyn Drake and John Marshall Gorham, 66, Victoria-street, Westminster.

19505. Improved methods and apparatus for electro-thermally treating materials. Hudson Maxim, 45, Southampton-buildings, Chancery-lane, London.

19507. Improvements in electrical arc lamps. Hans Carl Madsen, 65, Chancery-lane, London. (Complete specification.)

19528. Improvements in dynamo-electric machines and electric motors. Sidney Augustus Nash, 47, Lincoln's inn-fields London.

September 4.

19558. Improvements in printing telegraph instruments. Emile Michel Denis André, 47, Lincoln's-inn fields, London.

19583. Automatic closing telegraphic key. James Arthur Coleman, 89, Chancery-lane, London.

September 5.

19638. Improvements in electrical indicators. Isaac Hardy Parsons, 21, Narborough-road, Leicester.

19639. An improved mode of electrical gas lighting. Annibal Légé, 31, Kirby-street, Hatton-garden, London.

19650. Improvements in insulators. Thomas Blankinsop and Joseph Wilson Brown, 89, Chancery-lane, London.

19660. Improvements in or relating to apparatus for supplying a certain definite amount of electric current (for lighting or other purposes) on prepayment. William Dobson Watson, 4, St. Anne's-square, Manchester.

19664. Improvements in glass globes or shades for electric, gas, or other lights. Sowerby's Ellison Glass Works, Limited, 19, the Arcade, Barnsley.

19693. An improved electric switch for certain useful purposes. Walter Charles Bersey, Ernest Francis Moy, and Ernest F. Moy, Limited, 433, Strand, London.

SPECIFICATIONS PUBLISHED.

1895.

13164. Dynamos. Wise. (Maschinenfabrik Oerlikon.) (Amended.)

15445. Step-by-step printing telegraphs. Steljes.

16659. Electric railways. Belfield. (Foreign Electric Traction Company.)

17525. Electrolytical manufacture of bleaching liquid. Kellner.

19027. Electric metering apparatus. Wise. (Barstow.)

20237. Electric safety fuses. The Edison and Swan United Electric Light Company, Limited, and Proctor.

21543. Apparatus for transforming continuous electric currents into alternating currents. Abel. (La Société Anonyme pour la transmission de la force par l'Electricité.)

1896.

3910. Magnetic regulator for the carbons of arc lamps. Klostermann.

4944. Electric arc lamp carbon and apparatus for the manufacture of the same. Lorrain. (Foote.)

8382. Automatic circuit breakers for use in electric tramcars or other electrically-propelled vehicles. Devonshire. (Potter.)

14462. Systems of electrical distribution. Boult. (Scott and Janney.)

15102. Method of winding armatures for multipolar continuous-current dynamo-electric machines and electromotors. Royce and Claremont.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5¼-5¾
Brush Company, Ordinary	3	1⅜-1⅝
—— Non. Cum., 6 per cent. Pref.	2	1¾-2
—— 4½ per cent. Debenture Stock	100	110-113 x d
Central London Railway, Ordinary	10	10¼-10¾
——	2	4⅜-4⅝
Charing Cross and Strand	5	9¼-9¾
Chelsea Electricity Company	5	7¾-8¼
—— 4½ per cent. Debentures	100	114-117
City of London, Ordinary	10	16-17
—— 6 per cent. Cumulative Pref.	10	17½-18½
—— 5 per cent. Debenture Stock	100	132-136
City and South London Railway, Consolidated Ordinary	100	51-53
—— 4 per cent. Debenture Stock	100	136-138
—— 5 per cent. Pref. Shares	10	14½-15
County of London and Brush Provincial Co., Ordinary	10	8-9
—— 6 per cent. Cum. Pref.	10	13¾-14¼
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
Edison and Swan United Ordinary	3	1¾-2¼
—— 4½ per cent. Debentures	100	103-106
Electric Construction, Limited	2	1 7/16 1 9/16x d
—— 7 per cent. Cumulative Pref.	2	2¾-3¼
Elmore's Copper Depositing	2	¾-1
Elmore's Wire Company	2	⅜-⅝
W. T. Henley's Telegraph Works, Ordinary	10	18-19 x d
—— 7 per cent. Preference	10	18½-19½ x d
—— 4½ per cent. Debentures	100	110-115 x d
House-to-House Company, Ordinary	5	4-4½
—— 7 per cent. Preference	5	8¾-9¼
India Rubber and Gutta Percha Works	10	21½-22½
—— 4½ per cent. Debentures	100	107-110
Kensington and Knightsbridge Ordinary	5	10-10½
—— 6 per cent. Pref.	5	8¼-8¾
Liverpool Electric Supply, Ordinary	5	8-8½
Liverpool Overhead Railway	10	13¼-13¾
—— 5 per cent. Pref.	10	17⅜-17⅝
—— 4 per cent. Mortgage Debentures of £100	100	112½-114½
London Electric Supply	5	⅞-1⅛
Metropolitan Electric Supply	10	13-14
—— 4½ per cent. First Mortgage Debenture Stock	100	120-123
National Telephone, Ordinary	5	7¼-7¾
—— 6 per cent. Cum. First Pref.	10	17-19
—— 6 per cent. Cum. Second Pref.	10	17-19
—— 5 per cent. Non. Cum. Third Pref	5	6⅞-7⅜
—— 3½ per cent. Deb. Stock	100	107-110
Notting Hill Company	10	12-13
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8¼-8¾
—— £4½ shares	4½	7¼-7¾
Oriental Telephone and Electric Company	1	¼-⅜
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	105-107
Southampton Electric Company	5	4¾-5¼
St. James's and Pall Mall, Ordinary	5	12-13
—— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	40-43
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	—	8½-8¾
Westminster Electric Supply, Ordinary	5	11-12
Yorkshire House-to-House		7½-8

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NOTES.

Publication Received.—We have just received the *Bulletin* of the University of Wisconsin containing Mr. Ford's tests of American transformers. We hope shortly to refer further to the subject.

Belfast Mechanical Engineers.—The members of the Belfast Mechanical and Engineering Association, at the invitation of Mr. Stelfox, paid a visit to the Belfast Corporation gasworks on Saturday last and examined the working of the "water-gas" plant there.

Motorcarts.—It is stated that the Motorcar Club propose to celebrate the coming in force of the Locomotives Act on November 14 by a procession of motorcarts to Brighton and back. There are, however, several reasons why it is probable that the procession will not be a very great affair.

Personal.—The post of secretary to the Institution of Engineers and Shipbuilders in Scotland, which has been held by Mr. W. D. Millar for 25 years, but who is now retiring, has been secured by Mr. Edward H. Parker, from the experimental department of Messrs. William Denny and Bros.' yards at Dumbarton.

Gold-Leaf Electroscope.—Mr. L. Benoist, in a communication to the Paris Academie of Sciences, described a modification of the old-fashioned gold-leaf electroscope, by which he claims its sensibility is increased nearly 50 per cent. for small divergences. The modification consists simply in the use of three leaves instead of two only. But the day of the electroscope is somewhat gone by.

Light Railways.—In a memorandum issued by the Board of Trade, it is notified that any schemes under the Light Railways Act of the present year must be advertised in the local papers in October or April, and submitted to the Light Railway Commissioners and the county authorities in November and May. Any proposals not sufficiently forward to be advertised next month will have to go over until the spring.

Russian Railways.—There is a report that the Russian Ministry of Ways and Communications have resolved to try at once a series of experiments with electric locomotives on the St. Petersburg and Moscow and the St. Petersburg and Warsaw lines, and on the lines running through the Baltic provinces. Possibly the "electric locomotive" is the Heilmann engine, as it is certain that nothing can be done on these railways with electric traction in the usual sense of the term.

Lightning.—During a thunderstorm which passed over Lamberhurst, Kent, last week, the parish church was struck by lightning. The spire is a shingle-roofed one, and was partially stripped of its shingles, which were scattered in all directions, and one of the shores of the bell-frame was split. The walls were also cracked. None of the woodwork was fired. No information is to hand as to what the lightning conductor was doing, but it is to be presumed that no one nowadays would leave a church steeple without one. Evidently if there was one, it was not very efficient.

Steam-Pipe Coverings.—In a series of tests of non-conducting coverings for boilers and steam-pipes, made for an American insurance company by Prof. Chas. L. Norton, of the Massachusetts Institute of Technology, a somewhat novel method was adopted. The covered pipe was filled with oil, which was heated by a wire carrying an electric current. Obviously, when equilibrium is attained the amount of heat radiated from the pipe is equal to the heating effect of the current, which is easily calculated. Prof. Norton's results mainly relate to "mineral wool" and rock wool, both of which he condemns.

Light Units.—Whatever standard they may ultimately be referred to, it is probable that the Geneva photometric units will at least come into such use as is implied by their being included in text-books. Whether people will actually talk of luxes and lumens is quite a different matter. A technical journal, though not an electrical one, has written "luces," which logically implies "lumina"; but that, of course, is absurd. If they ever get used at all, the words will take English plurals, like any other units. A name for the unit of brightness which would have stood a better chance than these others has not been supplied. It is not our place to suggest one.

Metallic Silicides.—By means of the electric furnace Mr. Moissan has produced and investigated the carbides of most of the less easily reducible metals. Some similar work on the production of metallic silicides has been done by Mr. E. Vigoureux. According to the *Comptes-Rendus* of the Académie, it appears that Mr. Vigoureux finds that in general the heavy metals will not form definite compounds with silicon, though they will dissolve it. Neither will aluminium nor the alkali metals. But the metals of the iron group—chromium, manganese, copper, and platinum—appear to form silicides. There are apparently no silicides comparable to the metallic carbides which are attacked by water.

Gas and Oil Explosions.—On Monday in High street, Homerton, a mineral oil lamp was upset. It exploded, set the room on fire, and burned a woman so severely that she died in the Homerton Infirmary shortly afterwards. On Sunday a gas explosion at Haydon-road, Wimbledon, blew out the windows and doors of a house. Three persons in the house were severely injured, but are expected to recover, and two boys who happened to be walking past the house outside were knocked down and badly cut by the windows as they blew out. Lastly, it is stated that a branch of the telegraph school at Reading has been wrecked by a gas explosion, but in this case no personal injuries are reported.

A Wonderful Torpedo.—A torpedo is being secretly constructed at Boston, in America, by a Lieutenant Halpine, but has not escaped the eagle eye of the Dalziel agent. "It is to contain an electric motor of sufficient power to propel it for 22 knots by means of a screw, and also a great length of piano wire, by means of which the operator will control its movements." The operator "may be on shore or in a ship or small boat, or may, in case of necessity, float on the water by means of a life preserver." This last provision seems so entirely unnecessary, unless, indeed, the operator chooses to ride out to sea on the back of his torpedo until he meets an enemy's ship, and then deftly dismount and smash her up.

Very Cheap Illumination.—All sorts of arguments are pressed into service from time to time at town council meetings as reasons for not adopting electric lighting, and the last is the coming of acetylene. At Dudley a councillor informed his colleagues that there was "now a new illuminant called acetylene which was five times more powerful than gas, and could be supplied at 6d. per 1,000ft." Moreover, the plant sufficient to supply a town like Dudley could be laid down for £5,000. Thus a local paper has it, but of course the worthy councillor may have been misheard by the reporter. The council as a whole, however, clearly knew better, because they passed the resolution for the appointment of a committee to consider the electric lighting of the borough.

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An Electrical Autolycus.—At the Marylebone Police Court, a young man named Ernest Otter, of Cambridge-road, Hammersmith, has been charged with stealing a miscellaneous collection of articles, including a banjo, field glasses, musical-box, and gold pin, belonging to Mr. D. Cornfoot, a merchant, residing at 20, Lancaster-gate, Hyde Park. The prisoner was employed to fit up Mr. Cornfoot's house with the electric light, and the articles were missed and subsequently found at his rooms. The charge was not denied, but the prisoner was committed for trial. Something has been written and much has been said as to the wickedness of the wireman, but up to the present this has been exhibited in the way of bad work rather than in the felonious collection of portable property.

New Form of Cell.—It might be imagined that every possible way of arranging the zinc, carbon, and pot in a zinc-carbon cell had been tried by this time. However, the *Elektrotechnischer Anzeiger* describes a cell in which the zinc is in the form of a double cylinder with a flat bottom to it. In the annular space between the inner and outer zinc cylinders comes the carbon, which is also of cylindrical form, the three cylinders having the same axis. The annular spaces between the carbon and the zinc are filled with a paste in the usual way, and a store of liquid fills the innermost space. Details may be omitted, and would not in any event be of much use without an illustration, but the above is the principle of the thing. It is the invention of Mr. Paul Schmidt, of Berlin, and has been patented.

Direct Coupling to Gas-Engines.—There are so many exhibitions, large and small, this year that one is in danger of forgetting which is which. There has been one at Stuttgart. It is a local affair, but one noticeable thing in the account of the gas and oil engines exhibited there which is given by *Dinglers Polytechnisches Journal* is the direct-coupled dynamo and gas-engine of Korting Bros., of Hanover. One of these is figured and briefly described. The engine is a tandem cylinder one, with apparently a very moderately heavy flywheel for a gas engine, and the eight-pole dynamo is coupled to the same shaft. There, is, however, what looks like a very heavy strap rigger bolted on to the flywheel—for what purpose is not clear. A single-cylinder gas-engine direct coupled to a six-pole dynamo is also illustrated. Unfortunately, there are no details as to the performance of these machines.

Nuremberg Exhibition.—Brief reference has already been made to the Bavarian exhibition at Nuremberg. Their position on the spot naturally enables the Schuckert Company to make a big show there in the machinery building. They undertake the illumination of the exhibition, and the generating plant is, so to say, part of the show, being erected on a platform at the end of the machinery hall. Both continuous and alternating current systems are used for this, and there are considerably more arc lamps on the alternating-current mains than on the continuous ones. A prominent exhibit is the 300-kilowatt alternator with its field exciter on the same shaft. This machine, together with a high-voltage continuous-current dynamo and a converter, is illustrated and briefly described in the *Elektrotechnischer Anzeiger*. The converter is for producing single, two-phase, and three-phase alternating currents from a continuous current.

Obituary.—During the week the death has been announced of Prof. Luigi Palmieri, the director of the Vesuvius Observatory. Mr. Palmieri was at one time professor of physics in the marine college at Naples, and afterwards in the university. He devoted some considerable attention to terrestrial electricity and magnetism, and, for use in the Vesuvius Observatory, designed two new instruments, one for the study of the variations in the amount and kind of atmospheric electricity, and another an electrical seismograph. Prof. Palmieri was a member of the Italian Senate.—From America comes the news of the death of Prof. W. Shrader, the head of the electrical department at the Missouri University at Columbia in that State.—The death has also been announced of Dr. J. E. C. Munro, who was once a president of the British Association, and was the author of a work on the Patents, Designs, and Trade Mark Acts of 1883.

Cable-Eating Insects.—There have been some curious reports as to the destruction of the insulation of a cable in Tonquin by insects. It was put down to the white ants, but as the cable was lead sheathed, it was very reasonably objected that that had hitherto proved a sufficient protection against them. The French Telegraphic Department sent a portion of the damaged cable to Mr. E. L. Bouvier for examination. He found the insulation had been destroyed by the formation of a quantity of small holes, evidently the work of some insect. On a minute examination the heads of two insects were discovered which were believed to be those of white ants, and it is supposed that they must have got at the insulation either from a bad joint or some accidental hole in the lead covering. Whether the insects are the ordinary white ants or not, it appears certain that they belong to some species of termite. As a remedy it is suggested that the cotton covering should be treated with sulphate of copper.

Electro-Harmonic Society. — The first smoking concert of the season has been fixed by the Electro-Harmonic Society for Friday, September 25, 1896, at the St. James's Hall Restaurant, Regent-street, W., at eight o'clock. The musical directors are, as hitherto, Mr. T. E. Gatehouse and Mr. Alfred E. Izard, and the programme will be as follows—Part I.: glee, "By Celia's Arbour" (Horsley), the "Dilettante" Vocal Quartette; pianoforte solo, "Gavotte" (Sapellnikoff), Mr. Alfred E. Izard; song, "Maid of Athens" (Gounod), Mr. Frederick Bevan; recitation, "Mr. Stack's Story" (Adeler), Mr. W. G. Churcher; song, "Edward Gray" (Sullivan), Mr. Edward Dalzell; silver bells, "The Promise of Life" (Cowen), Mr. R. B. Hopkins; song, "Flow, Thou Regal Purple Stream" (Dr. Arnold), Mr. Robert Hilton; musical sketch, "The Opera" (Schneider), Mr. George Schneider. Part II.: glee, "Simple Simon" (Macy), the "Dilettante" Vocal Quartette; recitation, "McBrae's Plan" (Wood), Mr. W. G. Churcher; new song, "Lass o' mine" (F. Bevan), Mr. Frederick Bevan; silver bells, "Alice" (Ascher), Mr. R. B. Hopkins; song (with refrain), "The Clown's Song" (Hatton), Mr. E. Dalzell; song, "My Lodging is the Cellar here" (Old German), Mr. Robert Hilton; humorous song, "That Awful Joke" (Kent), Mr. George Schneider.

Chemical Society.—In the September issue of the *Journal* of the Chemical Society Messrs. H. B. Dixon and H. Bereton Baker's paper is printed, giving the results of their investigations as to whether Röntgen radiations are able to influence chemical change, either by starting it or by accelerating or diminishing it after it has been started by ordinary light. In all cases negative results were obtained. The substances tried were mixtures of carbon monoxide and oxygen (dried and moist), hydrogen and oxygen, hydrogen and chlorine, carbon monoxide and chlorine, hydrogen sulphide and sulphur dioxide, solutions of sodium sulphite and oxygen, slow oxidation of phosphorus, and the decomposition of hydrogen peroxide. The authors, however, give no countenance to the idea that the action of

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the rays on a photographic place takes place indirectly through a fluorescence of the glass back. Papers by Dr. A. Richardson and Miss Emily Forbey are on the subject of the formation of hydrogen peroxide in ethyl ether, amyl alcohol, and other organic substances under the influence of sunlight. Three of the "abstracts" relate to matters connected with electrolysis. Mr. Donato Tommasi's rotating cathode has been already described in these columns. From the investigations of Mr. Giacomo Carrara it appears that methyl alcohol used as a solvent exerts a dissociating effect on most electrolytes comparable with that exerted by water, but no constant ratio exists between the solutions of the same substance in water and methyl alcohol; which was to be expected. From another abstract, it seems that the dielectric constant for various mixtures of organic liquids is not calculable by the simple mixture rule. It is generally lower than this, but the reverse when ether is one of the liquids.

Mining Engineers.—The seventh annual general meeting of the Federated Institution of Mining Engineers was opened at Cardiff on Tuesday in the room of the South Wales Institute of Engineers, Park-place. The institution comprises six societies: the Chesterfield and Midland Counties Institution of Engineers, Midland Institute of Mining, Civil, and Mechanical Engineers, Mining Institute of Scotland, North of England Institute of Mining and Mechanical Engineers, North Staffordshire Institute of Mining and Mechanical Engineers, and South Staffordshire and East Worcestershire Institute of Mining Engineers. Mr. G. A. Mitchell, Newcastle, president of the institution, occupied the chair. It was announced that the newly-elected president of the institution was Mr. Lindsay Wood, the well-known engineer and colliery proprietor, of North Durham. The vice-presidents for the year include Sir W. T. Lewis and Sir Lowthian Bell. A paper on anthracite coal was read by Mr. W. D. Wight. He began by stating that while the production of anthracite coal in the United States had rapidly increased, until the output in 1895 reached the enormous total of 58 million tons, South Wales anthracite deposits had been comparatively neglected, and the trade for that quality of coal had languished. This could be explained only by the circumstances that in the past the purposes to which anthracite had been applied were limited. The benefits to the community, especially in great cities, arising from the use of an absolutely smokeless combustible ought not be lost sight of. Mr. Morgan W. Davies (Swansea) said anthracite coal could be burned in almost every variety of grate, and Mr. Hort (Wrexham) said in burning anthracite coal for household purposes they must discard "the old-fashioned notion" of poking the fire. Among the other subjects discussed were papers by Prof. W. Galloway on "Secondary Haulage," and by Mr. W. D. Wight on "Automatic Variable Expansion Gear."

An Electric Subway.—Many years ago it became apparent that Boston required additional facilities for the transportation of street-car passengers through the lower parts of the city. The problem was for a time somewhat solved by the introduction of a very complete system of overhead trolley lines covering the city and immediate suburbs. From the æsthetic and sentimental standpoints, to which the Americans are not always so blind as is generally believed, this wholesale introduction of the overhead wire was not acceptable, and, moreover, as the population increased, the electric roads proved inadequate to deal with the traffic in the congested portions of the city. This applies to the region about Boston Common, where, especially on Tremont-street, bordering its eastern side, blockades are of very frequent occurrence. The result was the formation of a commission to build a subway or subways to take the traffic in the vicinity of the Common, to build a tunnel under Beacon-hill, to build a tunnel in the vicinity of Scolley-square, and to lay out a new way from a point near the south-east corner of the Common to Franklin Park. The commission at once began its work, and the progress made has been described in the *Scientific American*. By surface and sub-surface surveys the exact nature of the ground was determined, and these preliminary investigations included studies with regard to the disposition of underground sewers, pipes, and conduits that might be met with on the line selected. Part of the subway is to be for two tracks and part for four, but the electrical part of the work appears still to be done. The rail-level is to be only about 17ft. below the surface of the ground, and consequently where the subway ran under trees there was trouble. These have, in general, been lifted bodily and left on the same spot. A trench was dug around the tree, and the earth was then undercut so as to form a great earth ball. Chains were passed beneath it and carried to four screwjacks, by means of which it was raised to the new level. "The operation being done in winter," says our contemporary, "enabled the engineers to secure a solid earth ball under the influence of frost, thereby greatly facilitating the work." No doubt that was a convenient way from an engineering point of view. It would be more interesting to know how the trees look at the present moment. Few English trees would survive such treatment.

Cycles and Telegraphs.—According to the *Scientific American*, special attention has been given by the Signal Corps of the United States army to provisions for temporary telegraphic or telephonic intercommunication, and among pending experiments are some relating to the naked wire telephone, a subject which has already been mentioned more than once in these notes. A more curious matter, however, is the use of bicycles for the reeling out and recovering of wire and outpost cable by bicycle, as to which it is said that the results have been very satisfactory, and the United States Army Signal Corps has now a bicycle equipped with an automatic reel that works perfectly. The attachment was made in San Antonio, Texas, under the supervision of its inventor, Captain R. E. Thompson, of the Signal Corps. The line was laid out and recovered at a moderate rate on the day of the first test. The speed was gradually increased, and it was found that the wire was paid out quickly. "After dismounting for a moment to reverse the action, the officer began a return trip, keeping in the middle of the road and riding hard. The recovery was perfectly made, the wire being spooled evenly and the tension was at no time troublesome, although the course of the line was occasionally departed from by many feet, showing that the problem of compensating for increased speed of the recovery due to increasing bulk of the spool has been solved. The time occupied in running out and then picking up the reel of wire was two minutes, the reel holding about one-third of a mile of cable. Practical use has been made of the equipment in sending messages at other times than on the trial trip." Our contemporary gives an illustration, not of the United States Army apparatus, but of a similar one designed by Mr. L. Kamm, a German, who, however, lives in this country. The apparatus for laying the wire weighs 7lb., and each mile of wire weighs 10lb. There has recently, we know, been a good deal done in the way of military cycling at Aldershot, but we must acknowledge as having derived from our American contemporary the news that part of it was the trial of Mr. Kamm's machine there. Except under very special conditions of country or climate, one would imagine that the method could not

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be of any great value for distances of more than a mile or two, and will probably fail to supersede flag signalling. A cycle even without its trail of wire cuts a poor figure on the rough ground of cross-country work.

Electrolysis of Water.—An abstract of a paper by Mr. Alexei Sokoloff in the *Annalen Physiker Chemie* has been published in the *Journal* of the Chemical Society. It deals with the question of the minimum E.M.F. required to produce electrolysis in water and the difficulties of determining it. According to Helmholtz, the E.M.F. required for the electrolysis of water depends directly on the densities of the hydrogen and oxygen at the electrodes; the smaller these densities, the weaker will be the E.M.F. required; and in a liquid from which all gas has been completely removed, the value must sink to zero. Helmholtz has further deduced an expression connecting the E.M.F. of polarisation, A, for any pressures, p_h and p_o, of the hydrogen and oxygen, with the E.M.F. when the pressure p_a is the atmospheric, and determined the value of this last quantity, A_a, as being 1·783 volts. A direct proof that the decomposition of water can be accomplished with any E.M.F., however small, has not yet been given, nor can Helmholtz's determination of A_a be regarded as final; the author has therefore submitted these points to further experimental investigation. In order to obtain proof of electrolysis when the E.M.F. is very small, a voltameter was arranged, which contained two platinum plates as electrodes, and in the immediate neighbourhood of each plate an insulated platinum point. When a current is passed, the electrodes become polarised by gas layers of definite density, but as these gases are electrically neutral, and therefore quite free, they diffuse through the liquid, and must in a short time reach the platinum points and polarise these just as each electrode was originally polarised. This polarisation can then be easily detected by means of a sensitive electrometer. The experiments quoted in the paper in which this arrangement was employed show that electrolysis can be produced by any E.M.F. however small. In contradiction to Helmholtz, the author finds that an E.M.F. of one volt suffices to produce gas of measurable pressure by the decomposition of water. Thus, in one experiment, which lasted 16 months, a calomel cell (1·072 volt) produced gas of 2·53mm. pressure, and from the continual increase in the pressure this seems to be even far below the limiting value. From the results it appears that difficulties are encountered in producing invisible electrolysis with a small E.M.F. similar to those met with when visible electrolysis is effected. Forces are active on the surfaces of the electrodes which restrain the gases from freely diffusing through the liquid, and bring about absorption of the gases by platinum and other metals. The forces here spoken of introduce difficulties in the determination of A_a from the results of experiments on visible electrolysis. Determinations which the author has made at low pressures give a value for A_a of 0·745 volt, which is much smaller than that given by Helmholtz.

Photometric Standards.—As we have already noted, about the only definite resolution arrived at at the electrical congress at Geneva was the recommendation of the Violle standard of light for adoption, by which all secondary standards are to be referred to the light emitted by one square centimetre of melted platinum at the point of solidification. This may or may not be adopted as a theoretical standard in France and elsewhere, but it is so expensive to set up (a relatively considerable quantity of platinum has to be melted), and such precautions must be observed, that it is altogether impossible as a practical standard. The Germans, it is pretty certain, will continue to use the Hefner lamp, which, by the resolutions of the congress, they are permitted to do "provisionally." Prof. E. Hospitalier, who presided over the discussion, however, says that this only means that they will call a "hefner" what the French call a "decimal candle," which is the practical unit. This depends on circumstances. The melting point of platinum cannot be altered, but, of course, it is always possible to adopt Prof. Mengarini's suggestion and alter the lamp if it does not turn out to be, as the "decimal" candle is, an accurate twentieth of the standard. The propriety of using such unhandy substances as melting platinum or incandescing carbon appears to have been taken all through as beyond discussion, and, indeed, Mr. Von Hefner Alteneck was asked at Geneva what his lamp was supposed to represent the equivalent of. That it might represent itself did not appear to be considered possible by any of the supporters of the Violle standard. Yet apart from questions of convenience, it does not seem clear why a given area of burning amyl acetate should be essentially improper as a standard in comparison with a specified area of melting platinum. Indeed, there seems no small amount of pedantry in the matter. A more practical question is the relation of the new standard, the "decimal candle," to the English candle. Different observers have determined the Hefner standard at various figures between ·88 and ·98 of the English candle, but as, on the best authority, the latter standard with the most careful use must be expected to vary 3·5 per cent., is very likely to vary as much as 8 per cent. and may vary 15 per cent., it is clear that any figures beyond the first decimal place are of a purely ornamental character, and it is therefore difficult to say much more than that the new candle would be a "little less" than the old one. A more serious objection is that the colour of the amyl acetate flame is distinctly redder than any of the lights in ordinary use. In a communication published in the *Transactions* of the American Institute of Electrical Engineers, Prof. R. A. Fessenden has emphasised this point. He says that two eyes may differ by 50 per cent. in their estimate of the relative brightness of a coloured light referred to a monochromatic one, and that with the various lights from white to yellow in ordinary use it would be impossible to get a greater accuracy than ½ per cent. from this cause alone. One of the few advantages of using an acetylene flame as a standard would be its white colour, as was pointed out in America by Mr. Steinmetz. But, after all, it does not very much matter, for the practical use of a unit of light is to enable one to say a given lamp is of so many candle-power—and that must always be a very rough matter.

Rontgen Radiations.—To-day (Friday), if the programme is carried out, the British Association is to discuss Prof. Röntgen's discovery at length. The subject has already been referred to in the presidential address, chiefly, of course, from the physiological side. Sir Joseph Lister is not altogether disinclined to lend countenance to the suggestion that the transmission of the radiations "through the human body may not be altogether a matter of indifference to the internal organs." This can hardly, however, be the case with such radiations, as the viscera are absolutely transparent to; for if the radiations pass through without losing any energy, they can obviously have done no work in their passage. But at the same time as the Röntgen radiations proper there are always generated a quantity of ordinary light, and no doubt also a very considerable amount of ultra-violet radiations, using that term in the ordinary sense. The latter are known to be extraordinarily effective in producing sunburn, and the skin irritation which has been

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observed to follow the long-continued action of the Röntgen apparatus on the human body may very probably be referred to constituents more nearly approaching radiations of this character than the true Röntgen ray. Such radiations would not penetrate deeply, and doubtless, if necessary, could be stopped by a suitable screen. When the subject is discussed at Liverpool it is to be hoped that mere descriptions of unconnected results will not be allowed to postpone an adequate treatment of the theory of the subject by those competent to deal with the question. The reluctance of the high authorities on the theory of light to say anything definite on the subject has been hitherto somewhat unaccountable. Some time ago Sir George Stokes took the occasion of a meeting of the Victoria Institute to pronounce in favour of the hypothesis of transverse vibrations of very small wave-length, but by the time his address came to be published he appeared to have changed his mind in favour of an explanation which should be not "periodic in character." What that may mean is not clear, unless it is something corpuscular. Some good mathematics and a great deal of bad speculation has been wasted on the subject, but the matter may be put quite shortly. Apart from an altogether new hypothesis, the only theory that gets over even elementary difficulties is that the Röntgen radiations are simply exceedingly short (invisible) light waves. Theoretical considerations show that such waves, as soon as they become of a size not much greater or smaller than the molecules or atoms, would act very much as the Röntgen rays do. The only difficulty is the mechanical one of conceiving how the atom is capable of giving vibrations of so high a frequency. But we know really nothing of the mechanics of the atom, so this is no objection. Moreover, there is another conception which is just possible. The original vibrations may not be those of the atom or molecule, but of portions of the luminiferous medium contained in the interstices of the molecule or atom. In that case the wave-lengths would be some simple fraction of the molecular or atomic dimensions—which is just what is wanted. The analogy of a metal tube containing air is immediately apparent in the case of sound-waves. The same result follows on the favourite, though, as it appears to the writer at present, unwarranted, theory of an atom with an "atmosphere" of "ether" sticking round it. And on the electromagnetic theory of light the violent projection of the highly "charged" molecules from the cathode on to the anode or the glass of the tube, seems about as likely a way of getting up this sort of vibration as any other. Anyone who works it out will see that this gives a possible explanation of many of the conditions necessary to get good radiation when the cathode rays are projected on the surface of the tube instead of on the anode. We do not, however, intend to attempt that here.

Scientific Education.—Prof. T. E. Thorpe, who has already expressed views on the subject elsewhere, cut into the *Times* correspondence on the way to make a chemical expert at the end of last week. He does not wish "to minimise the value of classical learning, or to underrate the services that Oxford, for example, has rendered to scholarship and literature," but "if the universities did more for science, the schools which they influence would follow suit, and a sounder public opinion concerning the part which science should play in education, and of the relation of science to industry, would more quickly grow." It is to be feared that if we have to wait for Oxford to produce him, the chemical researcher will not be very common yet awhile. A sort of mild socialism is more in the way of the advanced party on the Isis than anything scientific. Prof. Thorpe says the examination system is in fault. Of course it is; you can only examine in things that are known. If the honour went to the man that made the discovery instead of the man that topped the class list, it might be different. Mr. Friswell returns to the charge. His contention is that it is all the fault of the manufacturer. The German schools are open to the whole world, and large numbers of Englishmen and Americans study at them, but even when educated abroad Englishmen do not meet the chemical manufacturers' requirements. Though individual exceptions exist, the English manufacturer does not value science as he ought. The reason of this is the want of appreciation of the value of science which our ordinary system of education leaves in the minds of the public at large. Sir B. Samuelson, instead of complaining because the classical schoolmaster stands by his own trade, goes straight for the other people who wasted the money that might have been usefully applied "In 1889-91, thanks to Mr. Acland and Mr. Goschen, the 'beer money' was allowed to be applied to technical education, and because people had heard of great polytechnical schools on the Continent they set to work and established so-called 'polytechnics' on the model of the Polytechnic in Regent-street." The artisans of the Continent have, as a rule, no scientific instruction whatever, but in the great colour works of Germany doctors of philosophy direct every department. "To expect that we should vanquish our rival manufacturers by teaching chemistry or physics to our artisans is as if we were to prepare our army to conquer the enemy by instructing 'Tommy Atkins' in strategy and tactics." Lastly, Sir B. Samuelson praises general cultivation and a liberal rather than a scientific education. Theoretically, this is right, since a wide and general knowledge enables a man to quickly pick up and deal with new ideas and processes. Unfortunately, the advocate of a general education is a Janus-like being, who really means a specialisation in a portion of the literatures of an extinct civilisation. There is usually no great difficulty in getting round to the other face and making him dilate on the futility of "a mere smattering of science and modern languages." Sir B. Samuelson's letter called forth a reply from a correspondent who signs himself "Y," but who is evidently someone of authority, as the *Times* treats him to larger type than any of the others. Briefly, he thinks that it can do no harm for a workman to have a few right notions about his work instead of a great many wrong ones. "At the present time what career is open, except that of a teacher, to a thoroughly instructed chemist or physicist as such? What salary may he reasonably expect to get unless he has capital or 'business capacity'?" The conclusion is again, as before, that the first steps must be to clear away ignorance and apathy, and no longer to allow "the old universities to dominate all education and bribe all the rising talent into one narrow groove of intellectual training." Mr. J. E. Marsh comes up again with a suggestion that there should be an enquiry. That is futile, if you put the people responsible for the present system on the commission; they will not condemn themselves. If you do not, the enquiry will not be "impartial." Lastly, a Mr. W. Smith puts forward the curious view that the German boy works instead of plays at school because when he leaves it he has to go into the army and be bullied in a despicable way by the non-commissioned officer. The facts may be true, but there seems no logical connection between them. The reason why the English grammar school goes in for games and, having failed to teach classics, teaches cricket and football, is simply because it is the easiest and most popular thing to do. It would be no use flying from classics, which are hard, to science, which is harder.

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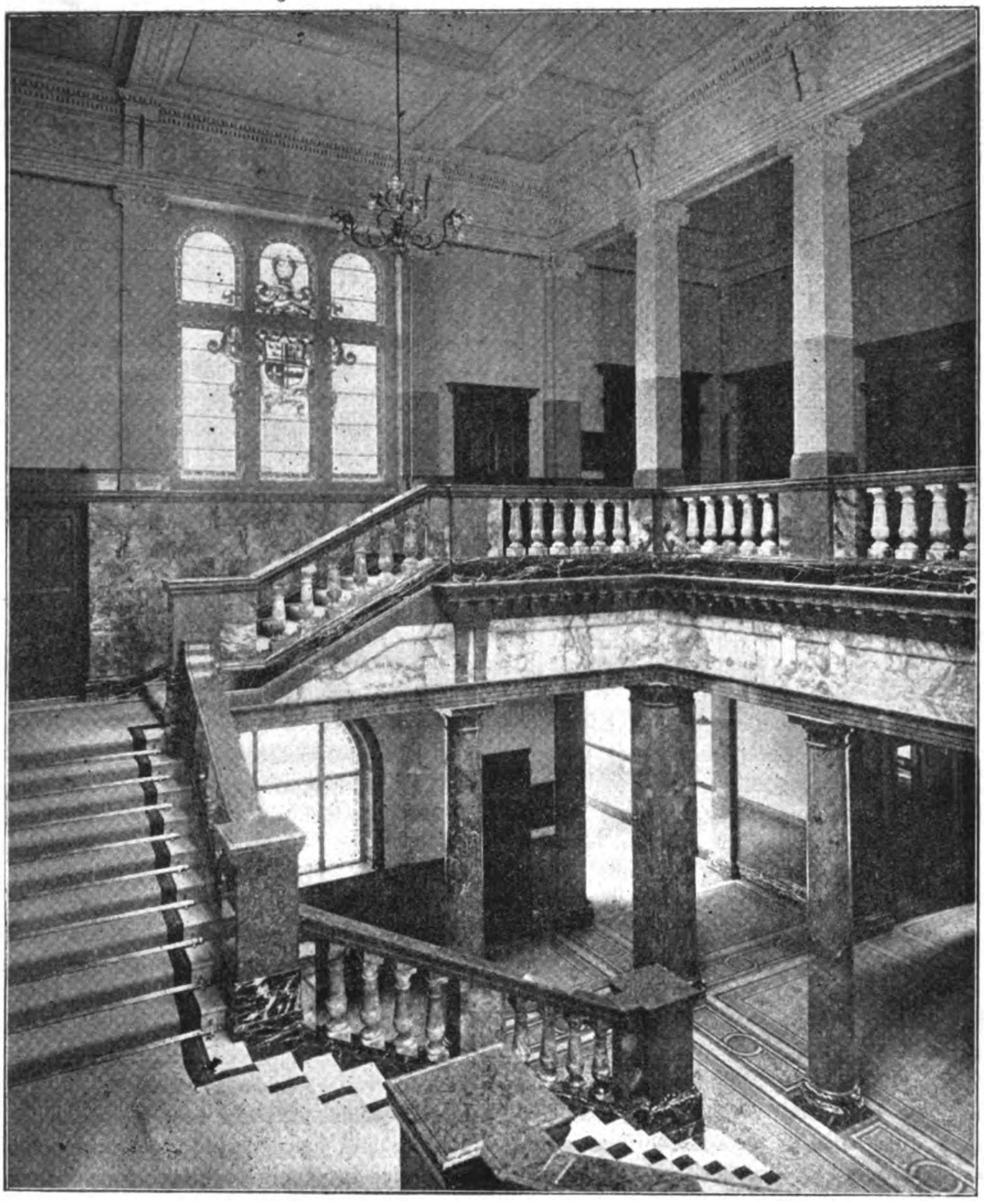
THE ELECTRIC LIGHTING OF THE CROYDON MUNICIPAL BUILDINGS.

This magnificent block of buildings at Croydon, recently opened by the Prince of Wales, contains accommodation for more than the ordinary municipal offices. Thus Mr. Charles Henman, A.R.I.B.A., the architect, in designing the work (now completed) provided for a public library, reading-rooms, and a corn exchange, in addition to the court-rooms, Council-chamber, and offices required for the municipal work. The architecture of the handsome block has been previously described in the public Press, and we need not do more than congratulate the Corporation and the architect on the outcome of their labours. The specification for the electric lighting was drawn out by an expert, under the superintendence of Mr. Henman, who has throughout sought to harmonise the fittings with the architecture. About 25 tenders were received, and it was decided to accept that of Messrs. Wenham and Waters, of Paragon Works, Croydon, whose price was £1,253. This selection was made in October last year, after a part of the decorative work had been begun. Still, the firm in question tackled the problem of wiring the building with promptitude, and have now practically finished the work. When the specifications were issued the pressure of supply was stated to be 100 volts, but this has been raised to 200 by the supply company. The sections of the wires and the sub-division of the circuits are thus most ample. We understand that the quality of the work was such that Prof. Kennedy did not hesitate in recommending the Corporation to accept supply at the higher voltage. The only alteration he advised, to make matters quite safe, was the replacing of the smaller switches which did not give sufficient length of break.

The supply from the street is led into a room in the basement of the buildings by a Callender concentric cable, which terminates in a Reid fuse-box. From this two single cables are led to the main switchboard. The lights controlled by this are equivalent to about 1,000 16-c.p. lamps, and are divided into two main circuits, each controlled by a large double-pole switch. One circuit supplies the municipal offices, Council-chamber, and the courts of justice, while the public library, the Braithwaite Hall, and the corn exchange are lighted by the other circuit. On a panel over the first one containing these two main switches is another with five double-pole distributing switches and fuses, which still further divides the main current. From these the cables, which are all of the Silvertown K type, as specified by the architect, are led throughout the building. The ventilating shafts and trunk mains have been greatly used for carrying the wires. The system of ventilating the building is roughly as follows: Each corridor is of some 3ft. lower pitch than the rooms adjoining it, and the space so formed



The Grand Staircase in the Municipal Buildings, Croydon.

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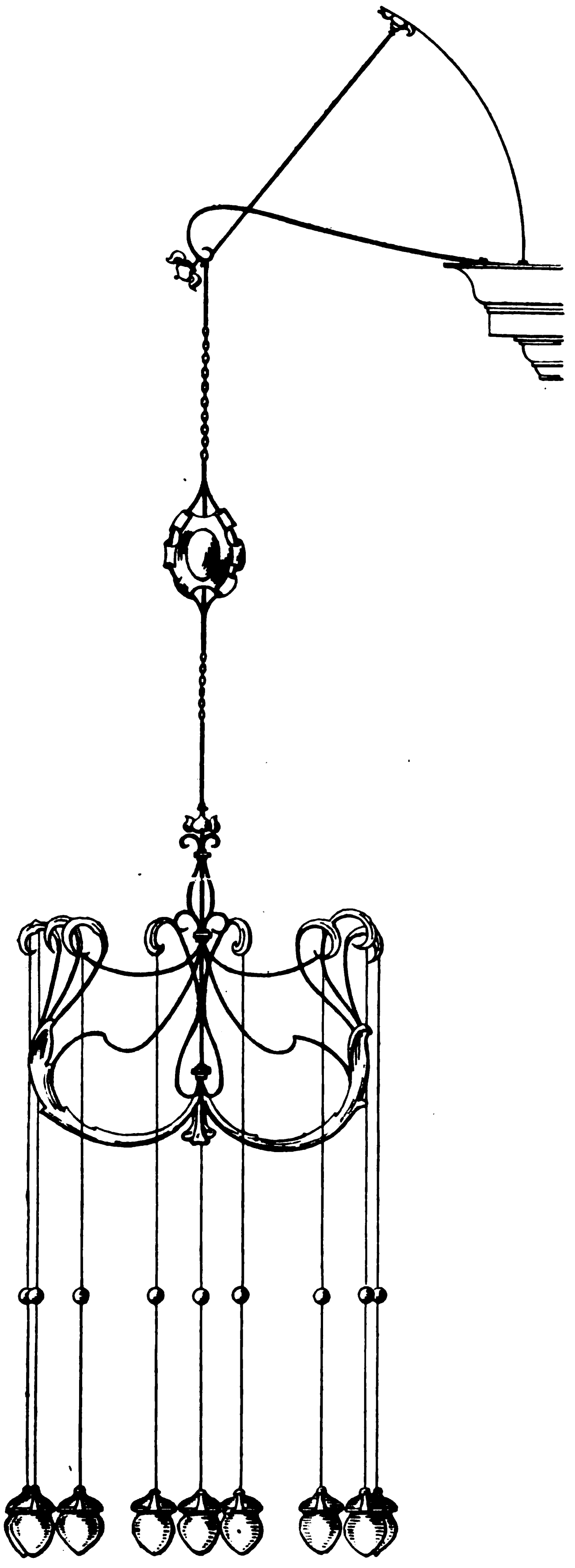
between the ceiling of one corridor and the floor of the next is used as an exhaust-air trunk. These trunks are connected by ventilating gratings to each room, and the hot or vitiated atmosphere so collected is taken through the



Sketch of the Fittings used in the Braithwaite Hall.

trunk to a main upcast flue. The centre of this flue is occupied by the boiler flue, and the heat from it assists the upward draught. The mains coming up the upcast are taken out from each floor, and are sub-divided first on a double-pole fuse-board to circuits of under 25 amperes—*i.e.*, 50 amperes on the 100-volt supply. From these the wires are led to further distributing fuse and switch boards at which a further sub-division to five-ampere circuits was intended. As, however, the voltage has been raised to 200 volts, no circuit leaving these boards will carry more than 2½ amperes. In these final circuits there is never any reduction of gauge of wire—a strand of seven 21½ gauge wires is the size which has been almost universally adopted. No fuses have been used in the fittings or in the ceiling roses of pendants, and hence nearly every fuse in the building is grouped and convenient of access. In the air-trunks, and in most of the offices, the wires are laid in wood casing, but where glazed brickwork has to be crossed in the corridors the wires are encased in iron pipes. In other places steel tubes are used embedded in the plaster, and suitable draw-boxes are then provided.

The fittings generally throughout the offices and corridors are of a simple type. The usual plain pendant with opal shade is strongly in evidence, and in most places harmonises well with the surroundings. In the office a few pendants to light the rooms generally are supplemented by simple brackets in the walls over the various desks. In several of the offices plugs are provided for portable lamps. In the two courts the lighting is effected by pendants dropping from the sides of the rectangular skylight. In the larger court the effect is most pleasing, but we did not care for it in the small building, where the individual lights come rather too close together. The highly insulated cords are then too prominent, and give a streaky appearance in daylight. When the lamps are alight this may not, however, be noticed. On the second floor are the committee-rooms, forming a range of three, with folding-doors between them. The first of these rooms will be used on occasions as a reception-room, and from it opens out the mayor's retiring-room. The fittings in this range are of graceful design, finished with a steel bronze, which is most pleasing. They are mostly for five lights each, but a few two-light wall brackets of the same general type are also used. It is in the Council-chamber that the most striking effects are found. The fittings here are designed on bold lines and executed in hammered iron and copper work. The lamps are hung from the fittings by flexible cords, as can be seen in the illustration of a similar fitting used in the Braithwaite Hall. In the Council-chamber are six long pendants, with fancy shade to each fitting, and one central lamp with larger shade. The general effect of these from the floor is exceedingly good. The designs for these fittings, and for those in the Braithwaite Hall, were drawn by Mr. F. E. Tomlinson from suggestions by and to the approval of Mr. Henman, and were manufactured by the Waltham Engineering Company in their Westminster works. The fittings used in the grand staircase can also be seen from the illustration. The attendant's rooms are in the tower and are approached by a spiral staircase. The lamps on this are wired to two tramway switches—one placed at the top and one at the bottom of the staircase. The connections are such that the lamps can be switched on or off from either switch, which is of great service. Thus, if the attendant is rung up after dark he can light the whole of the stairs simultaneously before he descends. The clock at top of the tower is also provided with electric light for illuminating the four dials. Ten lamps are used to each of the dials, which are 10ft. diameter. These are attached to a frame of ordinary electric light moulding, forming a circle about equal in diameter to that of the figures of the dial. These lamps are provided with enamelled iron reflectors, and are automatically switched on by a gear fixed to the clock, which gear has been designed by Messrs. Wenham and Waters. The public library adjoins the municipal building, and can be entered from it when desired by the officials. In the lending library simple pendants are used, arranged in lines between the book-racks. In the newsroom two-light pendants have been provided, and a most brilliant illumination is the result. The fittings in the reading-room, called the Braithwaite Hall, where the periodicals and the *Electrical Engineer* can be consulted, are illustrated above. The hall has been lighted several times this week, and general satisfaction has been expressed with the effect.

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THE BRITISH ASSOCIATION.

LIVERPOOL MEETING.

This year's meeting opened, as is usual, on Wednesday evening with the presidential address in the Philharmonic Hall. A large and brilliant assembly gathered together in this fine hall, when

Sir DOUGLAS GALTON, the retiring president, introduced his successor, and mentioned that personally he was not only retiring from the presidential chair—which high office signalled his retiring from the position of honorary secretary which he had so long held—but also severing a quarter of a century's official connection with the association. He then introduced his eminent successor to the chair.

Sir JOSEPH LISTER, Bart., D.C.L., LL.D., President Royal Society, then read his presidential address.

Presidential Address by Sir Joseph Lister, Bart., D C.L., LL.D., P.R.S.*

My Lord Mayor, my lords, ladies, and gentlemen,—I have first to express my deep sense of gratitude for the great honour conferred upon me by my election to the high office which I occupy to-day. It came upon me as a great surprise. The engrossing claims of surgery have prevented me for many years from attending the meetings of the association, which excludes from her sections medicine in all its branches. This severance of the art of healing from the work of the association was right, and, indeed, inevitable. Not that medicine has little in common with science. The surgeon never performs an operation without the aid of anatomy and physiology; and in what is often the most difficult part of his duty, the selection of the right course to follow, he, like the physician, is guided by pathology, the science of the nature of disease, which, though very difficult from the complexity of its subject-matter, has made during the last half-century astonishing progress; so that the practice of medicine in every department is becoming more and more based on science as distinguished from empiricism. I propose on the present occasion to bring before you some illustrations of the interdependence of science and the healing art; and the first that I will take is perhaps the most astonishing of all results of purely physical enquiry—the discovery of the Röntgen rays, so called after the man who first clearly revealed them to the world. Mysterious as they still are, there is one of their properties which we can all appreciate—their power of passing through substances opaque to ordinary light. There seems to be no relation whatever between transparency in the common sense of the term and penetrability to these emanations. The glasses of a pair of spectacles may arrest them while their wooden and leathern case allows them to pass almost unchecked. Yet they produce, whether directly or indirectly, the same effects as light upon a photographic plate. As a general rule the denser any object is the greater obstacle does it oppose to the rays. Hence, as bone is denser than flesh, if the hand or other part of the body is placed above the sensitive film enclosed in a case of wood or other light material at a suitable distance from the source of the rays, while they pass with the utmost facility through the uncovered parts of the lid of the box and powerfully affect the plate beneath, they are arrested to a large extent by the bones, so that the plate is little acted upon in the parts opposite to them, while the portions corresponding to the muscles and other soft parts are influenced in an intermediate degree. Thus a picture is obtained in which the bones stand out in sharp relief among the flesh, and anything abnormal in their shape or position is clearly displayed.

I need hardly point out what important aid this must give to the surgeon. As an instance, I may mention a case which occurred in the practice of Mr. Howard Marsh. He was called to see a severe injury of the elbow, in which the swelling was so great as to make it impossible for him by ordinary means of examination to decide whether he had to deal with a fracture or a dislocation. If it were the latter, a cure would be effected by the exercise of violence which would be not only useless but most injurious if a bone was broken. By the aid of the Röntgen rays a photograph was taken in which the bone of the upper arm was clearly seen displaced forwards on those of the fore-arm. The diagnosis being thus established, Mr. Marsh proceeded to reduce the dislocation; and his success was proved by another photograph which showed the bones in their natural relative position.

The common metals, such as lead, iron, and copper, being still denser than the osseous structures, these rays can show a bullet embedded in a bone, or a needle lodged about a joint. At the last conversazione of the Royal Society a picture produced by the new photography displayed with perfect distinctness through the bony framework of the chest a halfpenny low down in a boy's gullet. It had been there for six months, causing uneasiness at the pit of the stomach during swallowing, but whether the coin really remained impacted, or, if so, what was its position, was entirely uncertain till the Röntgen rays revealed it. Dr. Macintyre, of Glasgow, who was the photographer, informs me that when the presence of the halfpenny had been thus demonstrated the surgeon in charge of the case made an attempt to extract it, and although this was not successful in its immediate object, it had the effect of dislodging the coin, for a subsequent photograph by Dr. Macintyre not only showed that it had disappeared from the gullet, but also, thanks to the wonderful penetrating power which the rays had acquired in his hands, proved that it had not lodged further down in the alimentary passage. The boy has since completely recovered.

The Röntgen rays cause certain chemical compounds to fluoresce, and emit a faint light plainly visible in the dark; and if they are made to fall upon a translucent screen impregnated with such a salt, it becomes beautifully illuminated. If a part of the human body is interposed between the screen and the source of the rays, the bones and other structures are thrown in shadow upon it, and thus a diagnosis can be made without the delay involved in taking a photograph. It was in fact in this way that Dr. Macintyre first detected the coin in the boy's gullet. Mr. Herbert Jackson, of King's College, London, early distinguished himself in this branch of the subject. There is no reason to suppose that the limits of the capabilities of the rays in this way have yet been reached. By virtue of the greater density of the heart than the adjacent lungs with their contained air, the form and dimensions of that organ in the living body may be displayed on the fluorescent screen, and even its movements have been lately seen by several different observers.

Such important applications of the new rays to medical practice have strongly attracted the interest of the public to them, and I venture to think that they have even served to stimulate the investigations of physicists. The eminent Professor of Physics in the University College of this city (Prof. Lodge) was one of the first to make such practical applications, and I was able to show to the Royal Society at a very early period a photograph, which he had the kindness to send me, of a bullet embedded in the hand. His interest in the medical aspect of the subject remains unabated, and at the same time he has been one of the most distinguished investigators of its purely physical side.

There is another way in which the Röntgen rays connect themselves with physiology, and may possibly influence medicine. It is found that if the skin is long exposed to their action it becomes very much irritated, affected with a sort of aggravated sun burning. This suggests the idea that the transmission of the rays through the human body may be not altogether a matter of indifference to internal organs, but may, by long-continued action produce, according to the condition of the part concerned, injurious irritation or salutary stimulation.

This is the jubilee of anæsthesia in surgery. That priceless blessing to mankind came from America. It had, indeed, been foreshadowed in the first year of this century by Sir Humphry Davy, who, having found a toothache from which he was suffering relieved as he inhaled laughing gas (nitrous oxide), threw out the suggestion that it might perhaps be used for preventing pain in surgical operations. But it was not till on September 30, 1846, Dr. W. T. G. Morton, of Boston, after a series of experiments upon himself and the lower animals, extracted a tooth painlessly from a patient whom he had caused to inhale the vapour of sulphuric ether, that the idea was fully realised. He soon afterwards publicly exhibited his method at the Massachusetts General Hospital, and after that event the great discovery spread rapidly over the civilised world. I witnessed the first operation in England under ether. It was performed by Robert Liston in University College Hospital, and it was a complete success. Soon afterwards I saw the same great surgeon amputate the thigh as painlessly, with less complicated anæsthetic apparatus, by aid of another agent, chloroform, which was being powerfully advocated as a substitute for ether by Dr. (afterwards Sir James Y.) Simpson, who also had the great merit of showing that confinements could be conducted painlessly, yet safely, under its influence. These two agents still hold the field as general anæsthetics for protracted operations, although the gas originally suggested by Davy, in consequence of its rapid action and other advantages, has taken their place in short operations, such as tooth extraction. In the birthplace of anæsthesia ether has always maintained its ground, but in Europe it was to a large extent displaced by chloroform till recently, when many have returned to ether, under the idea that though less convenient, it is safer. For my own part, I believe that chloroform, if carefully administered on right principles, is, on the average, the safer agent of the two.

The discovery of anæsthesia inaugurated a new era in surgery. Not only was the pain of operations abolished, but the serious and sometimes mortal shock which they occasioned to the system was averted, while the patient was saved the terrible ordeal of

* We have condensed this most interesting address, as some of the subjects are hardly within our province.—ED. *E. E.*

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preparing to endure them. At the same time the field of surgery became widely extended, since many procedures in themselves desirable, but before impossible from the protracted agony they would occasion, became matters of routine practice. Nor have I by any means exhausted the list of the benefits conferred by this discovery.

My next illustration may be taken from the work of Pasteur on fermentations. It was natural that Pasteur should desire to know how the microbes which he showed to be the essential causes of the various fermentations took their origin. It was at that period a prevalent notion, even among many eminent naturalists, that such humble and minute beings originated *de novo* in decomposing organic substances; the doctrine of spontaneous generation, which had been chased successively from various positions which it once occupied among creatures visible to the naked eye, having taken its last refuge where the objects of study were of such minuteness that their habits and history were correspondingly difficult to trace. Here again Pasteur at once saw, as if by instinct, on which side the truth lay; and, perceiving its immense importance, he threw himself with ardour into its demonstration. I may describe briefly one class of experiments which he performed with this object. He charged a series of narrow-necked glass flasks with a decoction of yeast, a liquid peculiarly liable to alteration on exposure to the air. Having boiled the liquid in each flash to kill any living germs it might contain, he sealed its neck with a blow-pipe during ebullition, after which, the flask being allowed to cool, the steam within it condensed, leaving a vacuum above the liquid. If, then, the neck of the flask were broken in any locality, the air at that particular place would rush in to fill the vacuum, carrying with it any living microbes that might be floating in it. The neck of the flask having been again sealed, any germs so introduced would in due time manifest their presence by developing in the clear liquid. When any of such a series of flasks were opened and resealed in an inhabited room or under the trees of a forest, multitudes of minute living forms made their appearance in them, but if this was done in a cellar long unused, where the suspended organisms, like other dust, might be expected to have all fallen to the ground, the decoction remained perfectly clear and unaltered. The oxygen and other gaseous constituents of the atmosphere were thus shown to be of themselves incapable of inducing any organic development in yeast-water.

Such is a sample of the many well-devised experiments by which he carried to most minds the conviction that, as he expressed it, "*la génération spontanée est une chimère*," and that the humblest and minutest living organisms can only originate by parentage from beings like themselves.

Pasteur's labours on fermentation have had a very important influence upon surgery. I have been often asked to speak on my share in this matter before a public audience; but I have hitherto refused to do so, partly because the details are so entirely technical, but chiefly because I have felt an invincible repugnance to what might seem to savour of self-advertisement. The latter objection now no longer exists, since advancing years have indicated that it is right for me to leave to younger men the practice of my dearly loved profession. And it will perhaps be expected that, if I can make myself intelligible, I should say something upon the subject on the present occasion.

Nothing was formerly more striking in surgical experience than the difference in the behaviour of injuries according to whether the skin was implicated or not. Thus, if the bones of the leg were broken and the skin remained intact, the surgeon applied the necessary apparatus without any other anxiety than that of maintaining a good position of the fragments, although the internal injury to bones and soft parts might be very severe. If, on the other hand, a wound of the skin was present communicating with the broken bones, although the damage might be in other respects comparatively slight, the compound fracture, as it was termed, was one of the most dangerous accidents that could happen. Mr. Syme, who was, I believe, the safest surgeon of his time, once told me that he was inclined to think that it would be, on the whole, better if all compound fractures of the leg were subjected to amputation, without any attempt to save the leg. What was the cause of this astonishing difference? It was clearly in some way due to the exposure of the injured parts to the external world. One obvious effect of such exposure was indicated by the odour of the discharge, which showed that the blood in the wound had undergone putrefactive change, by which the bland nutrient liquid had been converted into highly irritating and poisonous substances. I have seen a man with compound fracture of the leg die within two days of the accident, as plainly poisoned by the products of putrefaction as if he had taken a fatal dose of some potent toxic drug.

An external wound of the soft parts might be healed in one of two ways. If its surfaces were clean cut and could be brought into accurate apposition, it might unite rapidly and painlessly "by the first intention." This, however, was exceptional. Too often the surgeon's efforts to obtain primary union were frustrated: the wound inflamed, and the retentive stitches had to be removed, allowing it to gape; and then, as if it had been left open from the first, healing had to be effected in the other way—*i.e.*, that of granulation and cicatrisation—a process which, when it proceeded unchecked to its completion, commanded our profound admiration. It was, however, essentially tedious compared with primary union, while, as we have seen, it was always preceded by more or less inflammation and fever, sometimes very serious in their effects. It was also liable to unforeseen interruptions.

It will be readily understood from the above description that the inflammation which so often frustrated the surgeon's endeavours after primary union was, in my opinion, essentially due to decomposition of blood within the wound.

These and many other considerations had long impressed me with the greatness of the evil of putrefaction in surgery. I had done my best to mitigate it by scrupulous ordinary cleanliness and the use of various deodorant lotions. But to prevent it altogether appeared hopeless while we believed with Liebig that its primary cause was the atmospheric oxygen which, in accordance with the researches of Graham, could not fail to be perpetually diffused through the porous dressings which were used to absorb the blood discharged from the wound. But when Pasteur had shown that putrefaction was a fermentation caused by the growth of microbes, and that these could not arise *de novo* in the decomposable substance, the problem assumed a more hopeful aspect. If the wound could be treated with some substance which, without doing too serious mischief to the human tissues, would kill the microbes already contained in it and prevent the future access of others in the living state, putrefaction might be prevented, however freely the air with its oxygen might enter. I had heard of carbolic acid as having a remarkable deodorising effect upon sewage, and having obtained from my colleague, Dr. Anderson, Professor of Chemistry in the University of Glasgow, a sample which he had of this product, then little more than a chemical curiosity in Scotland, I determined to try it in compound fractures. Applying it undiluted to the wound, with an arrangement for its occasional renewal, I had the joy of seeing these formidable injuries follow the same safe and tranquil course as simple fractures, in which the skin remains unbroken.

The appliances which I first used for carrying out the antiseptic principle were both rude and needlessly complicated. The years that have since passed have witnessed great improvements in both respects. Of the various materials which have been employed by myself and others, and their modes of application, I need say nothing except to express my belief, as a matter of long experience, that carbolic acid, by virtue of its powerful affinity for the epidermis and oily matters associated with it, and also its great penetrating power, is still the best agent at our disposal for purifying the skin around the wound.

Even our earlier and ruder methods of carrying out the antiseptic principle soon produced a wonderful change in my surgical wards in the Glasgow Royal Infirmary, which, from being some of the most unhealthy in the kingdom, became, as I believe I may say without exaggeration, the healthiest in the world, while other wards, separated from mine only by a passage a few feet broad, where former modes of treatment were for a while continued, retained their former insalubrity.

The striking results of the application of the germ theory to surgery acted as a powerful stimulus to the investigation of the nature of the micro-organisms concerned, and it soon appeared that putrefaction was by no means the only evil of microbic origin to which wounds were liable, and I ventured to express the view that, just as the various fermentations had each its special microbe, so it might be with the various complications of wounds. This surmise was afterwards amply verified.

Not that we can look forward with anything like confidence to being able ever to see the *materies morbi* of every disease of this nature. One of the latest of such discoveries has been that by Pfeiffer, of Berlin, of the bacillus of influenza, perhaps the most minute of all micro-organisms ever yet detected. The bacillus of anthrax, the cause of a plague common among cattle in some parts of Europe, and often communicated to sorters of foreign wool in this country, is a giant as compared with this tiny being; and supposing the microbe of any infectious fever to be as much smaller than the influenza bacillus as this is less than that of anthrax, a by no means unlikely hypothesis, it is probable that it would never be visible to man. The improvements of the microscope, based on the principle established by my father in the earlier part of the century, have apparently nearly reached the limits of what is possible. But that such parasites are really the causes of all this great class of diseases can no longer be doubted.

The first rational step towards the prevention or cure of disease is to know its cause; and it is impossible to overestimate the practical value of researches such as those to which I am now referring. Among their many achievements is what may be fairly regarded as the most important discovery ever made in pathology, because it revealed the true nature of the disease which causes more sickness and death in the human race than any other. It was made by Robert Koch, who at the London congress in 1881 showed to us for the first time the bacillus of tubercle. Wonderful light was thrown by this

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discovery upon a great group of diseases which had before been rather guessed than known to be of an allied nature; a precision and efficacy never before possible was introduced into their surgical treatment, while the physician became guided by new and sure light as regards their diagnosis and prevention.

At the same London congress Koch demonstrated to us his "plate culture" of bacteria, which is so important that it was soon introduced into his own institute and other laboratories throughout the world, and it has immensely facilitated bacteriological study. One fruit of it in Koch's own hands was the discovery of the microbe of cholera in India, whither he went to study the disease.

I have next to invite your attention to some earlier work of Pasteur. There is a disease known in France under the name of *choléra des poules*, which often produced great havoc among the poultry yards of Paris. It had been observed that the blood of birds that had died of this disease was peopled by a multitude of minute bacteria, not very dissimilar in form and size to the microbe of the lactic ferment to which I have before referred. And Pasteur found that, if this bacterium was cultivated outside the body for a protracted period under certain conditions, it underwent a remarkable diminution of its virulence; so that, if inoculated into a healthy fowl, it no longer caused the death of the bird, as it would have done in its original condition, but produced a milder form of the disease which was not fatal. And this altered character of the microbe, caused by certain conditions, was found to persist in successive generations cultivated in the ordinary way. Thus was discovered the great fact of what Pasteur termed the *atténuation des virus*, which at once gave the clue to understanding what had before been quite mysterious, the difference in virulence of the same disease in different epidemics.

But he made the further very important observation that a bird which had gone through the mild form of the complaint had acquired immunity against it in its most virulent condition. Pasteur afterwards succeeded in obtaining mitigated varieties of microbes for some other diseases, and he applied with great success the principle which he had discovered. The preparations used for such preventive inoculations he termed "vaccins" in honour of our great countryman, Edward Jenner. For Pasteur at once saw the analogy between the immunity to fowl-cholera produced by its attenuated virus and the protection afforded against small-pox by vaccination.

In 1880 Pasteur entered upon the study of that terrible but then most obscure disease, hydrophobia or rabies, which from its infective character he was sure must be of microbic origin, although no micro-organism could be detected in it. He early demonstrated the new pathological fact that the virus had its essential seat in the nervous system. This proved the key to his success in this subject.

It was shown several years ago by Roux and Yersin, working in the Institut Pasteur, that the crust or false membrane which forms upon the throats of patients affected with diphtheria contains bacteria which can be cultivated outside the body in a nutrient liquid, with the result that it acquires poisonous qualities of astonishing intensity, comparable to that of the secretion of the poison gland of the most venomous serpents. And they also ascertained that the liquid retained this property after the microbes had been removed from it by filtration, which proved that the poison must be a chemical substance in solution, as distinguished from the living element which had produced it. These poisonous products of bacteria, or toxins, as they have been termed, explain the deadly effects of some microbes, which it would otherwise be impossible to understand. Thus, in diphtheria itself the special bacillus does not become propagated in the blood, but remains confined to the surface on which it first appeared, but the toxin which it secretes is absorbed from that surface into the blood, and so poisons the system. Similar observations have been made with regard to the microbes of some other diseases, as, for example, the bacillus of tetanus or lockjaw. This remains localised in the wound, but forms a special toxin of extreme potency, which becomes absorbed and diffused through the body.

Wonderful as it seems, each poisonous microbe appears to form its own peculiar toxin. Koch's tuberculin was of this nature, a product of the growth of the tubercle bacillus in culture media. Here, again, great effects were produced by extremely minute quantities of the substance. Results led Koch to believe that he had obtained an effectual means of dealing with tubercular disease in all its forms. Unhappily, the apparent cure proved to be only of transient duration, and the high hopes which had been inspired by Koch's great reputation were dashed. It is but fair to say that he was strongly urged to publish before he was himself disposed to do so, and we cannot but regret that he yielded to the pressure put upon him.

Still, valuable results sprang from Koch's work on tuberculin, which has also indirectly done good in other ways. His distinguished pupil, Behring, has expressly attributed to those researches the inspiration of the work which led him and his since famous collaborateur, the Japanese Kitasato, to their surprising discovery of anti-toxic serum. They found that if an animal of a species liable to diphtheria or tetanus received a quantity of the respective toxin, so small as to be harmless, and afterwards, at suitable intervals, successively stronger and stronger doses, the creature, in course of time, acquired such a tolerance for the poison as to be able to receive with impunity a quantity very much greater than would at the outset have proved fatal. So far, we have nothing more than seems to correspond with the effects of the increasingly potent cords in Pasteur's treatment of rabies. But what was entirely new in their results was that if blood was drawn from an animal which had acquired this high degree of artificial immunity, and some of the clear fluid or serum which exuded from it after it had clotted was introduced under the skin of another animal, this second animal acquired a strong, though more transient, immunity against the particular toxin concerned. The serum in some way counteracted the toxin, or was antitoxic. But, more than that, if some of the antitoxic serum was applied to an animal after it had already received a poisonous dose of the toxin, it preserved the life of the creature, provided that too long a time had not elapsed after the poison was introduced. In other words, the antitoxin proved to be not only preventive but curative.

Similar results were afterwards obtained by Ehrlich, of Berlin, with some poisons not of bacterial origin but derived from the vegetable kingdom, and quite recently the independent labours of Calmette, of Lille and Fraser, of Edinburgh, have shown that antidotes of wonderful efficacy against the venom of serpents may be procured on the same principle.

Behring's darling object was to discover means of curing tetanus and diphtheria in man. In tetanus the conditions are not favourable because the specific bacilli lurk in the depths of the wound and only declare their presence by symptoms caused by their toxin having been already in a greater or less amount diffused through the system, and in every case of this disease there must be a fear that the antidote may be applied too late to be useful; but in diphtheria the bacilli very early manifest their presence by the false membrane which they cause upon the throat, so that the antitoxin has a fair chance, and here we are justified in saying that Behring's object has been attained.

I might have taken equally striking illustrations of my theme from other departments in which microbes play no part; in fact, any attempt to speak of all that the art of healing has borrowed from science and contributed to it during the past half-century would involve a very extensive dissertation on pathology and therapeutics. I have culled specimens from a wide field, and I only hope that in bringing them before you I have not overstepped the bounds of what is fitting before a mixed company. For many of you my remarks can have had little, if any, novelty; for others they may, perhaps, possess some interest as showing that medicine is no unworthy ally of the British Association—that, while her practice is ever more and more based on science, the ceaseless efforts of her votaries to improve what have been fittingly designated *Quæ prosunt omnibus artes*, are ever adding largely to the sum of abstract knowledge.

Address to the Mathematical and Physical Section.

BY PROF. J. J. THOMSON, M.A., F.R.S., PRESIDENT OF THE SECTION.

There is a melancholy reminiscence connected with this meeting of our section, for when the British Association last met in Liverpool the chair in Section A was occupied by Clerk-Maxwell. In the quarter of a century which has elapsed since that meeting, one of the most important advances made in our science has been the researches which, inspired by Maxwell's view of electrical action, confirmed that view and revolutionised our conception of the processes occurring in the electromagnetic field. When the association last met in Liverpool Maxwell's view was almost without supporters; to-day its opponents are fewer than its supporters then. Maxwell's theory, which is the development and extension of Faraday's, has not only affected our way of regarding the older phenomena of electricity—it has, in the hands of Hertz and others, led to the discovery of whole regions of phenomena previously undreamt of. It is sad to think that his premature death prevented him from reaping the harvest he had sown. His writings are, however, with us, and are a storehouse to which we continually turn, and never, I think, without finding something valuable and suggestive.

"Thus ye teach us day by day
Wisdom, though now far away."

The past year has been rich in matters of interest to physicists. In it has occurred the jubilee of Lord Kelvin's tenure of the professorship of natural philosophy at the University of Glasgow. Some of us were privileged to see this year at Glasgow an event unprecedented in the history of physical science in England, when congratulations to Lord Kelvin on the jubilee of his professorship were offered by people of every condition and country. Every scientific society and every

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scientific man is Lord Kelvin's debtor; but no society and no body of men owe him a greater debt than Section A of the British Association. He has done more for this section than anyone else; he has rarely missed its meetings; he has contributed to the section papers which will make its proceedings imperishable, and by his enthusiasm he has year by year inspired the workers in this section to renew with increased vigour their struggles to penetrate the secrets of nature. Long may we continue to receive from him the encouragement and assistance which have been so freely given for the past half-century.

By the death of Sir W. R. Grove, the inventor of Grove's cell, we have lost a physicist whose name is a familiar one in every laboratory in the world. Besides the Grove cell, we owe to him the discovery of the gas battery, and a series of researches on the electrical behaviour of gases, whose importance is only now beginning to be appreciated. His essay on the correlation of the physical forces had great influence in promoting that belief in the unity of the various branches of physics which is one of the characteristic features of modern natural philosophy.

In the late Prof. Stoletow, of Moscow, we have lost the author of a series of most interesting researches on the electrical properties of gases illuminated by ultra-violet light, researches which from their place of publication are, I am afraid, not so well known in this country as they deserve to be.

As one who unfortunately of late years has had only too many opportunities of judging of the teaching of science in our public and secondary schools, I should like to bear testimony to the great improvement which has taken place in the teaching of physics in these schools during the past 10 years. The standard attained in physics by the pupils of these schools is increasing year by year, and great credit is due to those by whose labours this improvement has been accomplished. I hope I may not be considered ungrateful if I express the opinion that in the zeal and energy which is now spent in the teaching of physics in schools there may lurk a temptation to make the pupils cover too much ground. You may by careful organisation and arrangement ensure that boys shall be taken over many branches of physics in the course of a short time; it is, indeed, not uncommon to find boys of 17 or 18 who have compassed almost the whole range of physical subjects. But, although you may increase the rate at which information is acquired, you cannot increase in anything like the same proportion the rate at which the subject is assimilated so as to become a means of strengthening the mind and a permanent mental endowment when the facts have long been forgotten.

Physics can be taught so as to be a subject of the greatest possible educational value; but when it is so, it is not so much because the student acquires a knowledge of a number of interesting and important facts as by the mental training the study affords in, as Maxwell said, "bringing our theoretical knowledge to bear on the objects and the objects on our theoretical knowledge." I think this training can be got better by going very slowly through such a subject as mechanics, making the students try innumerable experiments of the simplest and, what is a matter of importance in school teaching, of the most inexpensive kind, but always endeavouring to arrive at numerical results rather than by attempting to cover the whole range of mechanics, light, heat, sound, electricity, and magnetism. I confess I regret the presence in examinations intended for school boys of many of these subjects.

I think, too, that in the teaching of physics at our universities there is perhaps a tendency to make the course too complex and too complete. I refer especially to the training of those students who intend to become physicists. I think that after a student has been trained to take accurate observations, to be alive to those pitfalls and errors to which all experiments are liable, mischief may in some cases be done if, with the view of learning a knowledge of methods, he is kept performing elaborate experiments, the results of which are well known. It is not given to many to wear a load of learning lightly as a flower. With many students a load of learning, especially if it takes a long time to acquire, is apt to crush enthusiasm. Now, there is, I think, hardly any quality more essential to success in physical investigations than enthusiasm. Any investigation in experimental physics requires a large expenditure of both time and patience; the apparatus seldom, if ever, begins by behaving as it ought; there are times when all the forces of nature, all the properties of matter, seem to be fighting against us; the instruments behave in the most capricious way, and we appreciate Coutts Trotter's saying that the doctrine of the constancy of nature could never have been discovered in a laboratory. These difficulties have to be overcome, but it may take weeks or months to do so, and unless the student is enthusiastic he is apt to retire disheartened from the contest. I think, therefore, that the preservation of youthful enthusiasm is one of the most important points for consideration in the training of physicists. In my opinion this can best be done by allowing the student, even before he is supposed to be acquainted with the whole of physics, to begin some original research of a simple kind under the guidance of a teacher who will encourage him and assist in the removal of difficulties. If the student once tastes the delights of the successful completion of an investigation he is not likely to go back, and will be better equipped for investigating the secrets of nature than if, like the White Knight of "Alice in Wonderland," he commences his career knowing how to measure or weigh every physical quantity under the sun, but with little desire or enthusiasm to have anything to do with any of them. Even for those students who intend to devote themselves to other pursuits than physical investigation, the benefits derived from original investigation as a means of general education can hardly be over-estimated, the necessity it entails of independent thought, perseverance in overcoming difficulties, and the weighing of evidence gives it an educational value which can hardly be rivalled. We have to congratulate ourselves that through the munificence of Mr. Ludwig Mond in providing and endowing a laboratory for research, the opportunities for pursuing original investigations in this country have been greatly increased.

The discovery at the end of last year by Prof. Röntgen of a new kind of radiation from a highly exhausted tube through which an electric discharge is passing, has aroused an amount of interest unprecedented in the history of physical science. The effects produced inside such a tube by the cathode rays, the bright phosphorescence of the glass, the shadows thrown by opaque objects, the deflection of the rays by a magnet, have, thanks to the researches of Crookes and Goldstein, long been familiar to us, but it is only recently that the remarkable effects which occur outside such a tube have been discovered. In 1893, Lenard, using a tube provided with a window made of a very thin plate of aluminium, found that a screen impregnated with a solution of a phosphorescent substance became luminous if placed outside the tube in the prolongation of the line from the cathode through the aluminium window. He also found that photographic plates placed outside the tube in this line were affected, and electrified bodies were discharged: he also obtained by these rays photographs through plates of aluminium or quartz. He found that the rays were affected by a magnet, and regarded them as the prolongations of the cathode rays. This discovery was at the end of last year followed by that of Röntgen, who found that the region round the discharge tube is traversed by rays which affect a photographic plate after passing through substances such as aluminium or cardboard, which are opaque to ordinary light; which pass from one substance to another, without any refraction, and with but little regular reflection; and which are not affected by a magnet. We may, I think, for the purposes of discussion, conveniently divide the rays occurring in or near a vacuum tube traversed by an electric current into three classes, without thereby implying that they are necessarily distinctly different in physical character. We have (1) the cathode rays inside the tube, which are deflected by a magnet; (2) the Lenard rays outside the tube, which are also deflected by a magnet; and (3) the Röntgen rays, which are not, as far as is known, deflected by a magnet. Two views are held as to the nature of the cathode rays—one view is that they are particles of gas carrying charges of negative electricity and moving with great velocities which they have acquired as they travelled through the intense electric field which exists in the neighbourhood of the negative electrode. The phosphorescence of the glass is on this view produced by the impact of these rapidly moving charged particles, though whether it is produced by the mechanical violence of the impact or whether it is due to an electromagnetic impulse produced by the sudden reversal of the velocity of the negatively-charged particle—whether, in fact, it is due to mechanical or electrical causes, is an open question. This view of the constitution of the cathode rays explains in a simple way the deflection of those rays in a magnetic field, and it has lately received strong confirmation from the results of an experiment made by Perrin. Perrin placed inside the exhausted tube a cylindrical metal vessel with a small hole in it, and connected this cylinder with the leaves of a gold-leaf electroscope. The cathode rays could, by means of a magnet, be guided so as either to pass into the cylinder through the aperture, or turned quite away from it. Perrin found that when the cathode rays passed into the cylinder the gold leaf of the electroscope diverged, and had a negative charge, showing that the bundle of cathode rays enclosed by the cylinder had a charge of negative electricity. Crookes had many years ago exposed a disc connected with a gold-leaf electroscope to the bombardment of the cathode rays, and found that the disc received a slight positive charge; with this arrangement, however, the charged particles had to give up their charges to the disc if the gold leaves of the electroscope were to be affected, and we know that it is extremely difficult, if not impossible, to get electricity out of a charged gas merely by bringing the gas in contact with a metal. Lord Kelvin's electric strainers are an example of this. It is a feature of Perrin's experiment that since it acts by induction the indications of the electroscope are independent of the communication of the charges of electricity from the gas to the cylinder, and since the cathode rays fall on the inside of the cylinder, the electroscope would not be affected, even if there were such an effect as is produced when ultra-violet light falls upon the

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surface of an electro-negative metal when the metal acquires a positive charge. Since any such process cannot affect the total amount of electricity inside the cylinder, it will not affect the gold leaves of the electroscope ; in fact, Perrin's experiments proved that the cathode rays carry a charge of negative electricity.

The other view held as to the constitution of the cathode rays is that they are waves in the ether. It would seem difficult to account for the result of Perrin's experiment on this view, and also I think very difficult to account for the magnetic deflection of the rays. Let us take the case of a uniform magnetic field. The experiments which have been made on the magnetic deflection of these rays seem to make it clear that in a magnetic field which is sensibly uniform, the path of these rays is curved. Now, if these rays were due to ether waves, the curvature of the path would show that the velocity of propagation of these waves varied from point to point of the path. That is, the velocity of propagation of these waves is not only affected by the magnetic field, it is affected differently at different parts of the field. But in a uniform field what is there to differentiate one part from another, so as to account for the variability of the velocity of wave propagation in such a field? The curvature of the path in a uniform field could not be accounted for by supposing that the velocity of this wave motion depended on the strength of the magnetic field, or that the magnetic field, by distorting the shape of the boundary of the negative dark space, changed the direction of the wave front, and so produced a deflection of the rays. The chief reason for supposing that the cathode rays are a species of wave motion is afforded by Lenard's discovery, that when the cathode rays in a vacuum tube fall on a thin aluminium window in the tube, rays having similar properties are observed on the side of the window outside the tube ; this is readily explained on the hypothesis that the rays are a species of wave motion to which the window is partially transparent, while it is not very likely that particles of the gas in the tube could force their way through a piece of metal. This discovery of Lenard's does, not, however, seem to me incompatible with the view that the cathode rays are due to negatively charged particles moving with high velocities. The space outside Lenard's tube must have been traversed by Röntgen rays ; these would put the surrounding gas in a state in which a current would be readily started in the gas if any E.M.F. acted upon it. Now, though the metal window in Lenard's experiments was connected with the earth and would, therefore, screen off from the outside of the tube any effect arising from slow electrostatic changes in the tube, it does not follow that it would be able to screen off the electrostatic effect of charged particles moving to and from the tube with very great rapidity. For in order to screen off electrostatic effects there must be a definite distribution of electrification over the screen ; changes in this distribution, however, take a finite time, which depends upon the dimensions of the screen and the electrical conductivity of the material of which it is made. If the electrical changes in the tube take place at above a certain rate, the distribution of electricity on the screen will not have time to adjust itself, and the screen will cease to shield off all electrostatic effects. Thus the very rapid electrical changes which would take place if rapidly moving charged bodies were striking against the window might give rise to E.M.F.'s in the region outside the window, and produce convection currents in the gas which has been made a conductor by the Röntgen rays. The Lenard rays would thus be analogous in character to the cathode rays, both being convective currents of electricity. Though there are some points in the behaviour of these Lenard rays which do not admit of a very ready explanation from this point of view, yet the difficulties in its way seem to me considerably less than that of supposing that a wave in the ether can change its velocity when moving from point to point in a uniform magnetic field.

I now pass on to the consideration of the Röntgen rays. We are not yet acquainted with any crucial experiment which shows unmistakably that these rays are waves of transverse vibration in the ether, or that they are waves of normal vibration, or, indeed, that they are vibrations at all. As a working hypothesis, however, it may be worth while considering the question whether there is any property known to be possessed by these rays which is not possessed by some form or other of light. The many forms of light have in the last few months received a noteworthy addition by the discovery of M. Becquerel of an invisible radiation, possessing many of the properties of the Röntgen rays, which is emitted by many fluorescent subtances, and to an especially marked extent by the uranium salts. By means of this radiation, which, since it can be polarised, is unquestionably light, photographs through opaque substances similar to, though not so beautiful as, those obtained by means of Röntgen rays, can be taken, and, like the Röntgen rays, they cause an electrified body on which they shine to lose its charge, whether this be positive or negative.

The two respects in which the Röntgen rays differ from light is in the absence of refraction, and perhaps of polarisation. Let us consider the absence of refraction first. We know cases in which special rays of the spectrum pass from one substance to another without refraction—for example, Kundt showed that gold, silver, copper allow some rays to pass through them without bending, while other rays are bent in the wrong direction. Pflüger has lately found that the same is true for some of the aniline dyes when in a solid form. In addition to this, the theory of dispersion of light shows that there will be no bending when the frequency of the vibration is very great. I have here a curve taken from a paper by Helmholtz, which shows the relation between the refractive index and the frequency of vibration for a substance whose molecules have a natural period of vibration, and one only ; the frequency of this vibration is represented by O K in the diagram. The refractive index increases with the frequency of the light until the latter is equal to the frequency of the natural vibration of the substance ; the refractive index then diminishes, becomes less than unity, and finally approaches unity, and is practically equal to it when the frequency of the light greatly exceeds that of the natural vibration of the molecule. Helmholtz's results are obtained on the supposition that a molecule of the refracting substance consists of a pair of oppositely electrified atoms, and that the specific inductive capacity of the medium consists of two parts—one due to the ether, the other to the setting of the molecules along the lines of electric force.

Starting from this supposition, we can easily see without mathematical analysis that the relation between the refractive index and the frequency must be of the kind indicated by the curve. Let us suppose that an E.M.F. of given amplitude acts on this mixture of molecules and ether, and let us start with the frequency of the external E.M.F. less than that of the free vibrations of the molecules. As the period of the force approaches that of the molecules the effect of the force in pulling the molecules into line will increase. Thus the specific inductive capacity, and therefore the refractive index, increases with the frequency of the external force. The effect of the force on the orientation of the molecules will be greatest when the period of the force coincides with that of the molecules. As long as the frequency of the force is less than that of the molecules, the external field tends to make the molecules set so as to increase the specific inductive capacity of the mixture. As soon, however, as the frequency of the force exceeds that of the molecules, the molecules, if there are no viscous forces, will all topple over and point so as to make the part of the specific inductive capacity due to the molecules of opposite sign to that due to the ether. Thus, for frequencies greater than that of the molecules the specific inductive capacity will be less than unity. When the frequency of the force only slightly exceeds that of the molecules, the effect of the external field on the molecules is very great, so that if there are a considerable number of molecules, the negative part of the specific inductive capacity due to the molecules may be greater than the positive part due to the ether, so that the specific inductive capacity of the mixture of molecules and ether would be negative; no waves of this period could then travel through the medium: they would be totally reflected from the surface.

As the frequency of the force gets greater and greater, its effect in making the molecules set will get less and less, but the waves will continue to be totally reflected until the negative part of the specific inductive capacity due to the molecules is just equal to the positive part due to the ether. Here the refractive index of the mixture is zero. As the frequency of the force increases, its effect on the molecules gets less and less, so that the specific inductive capacity continually approaches that due to the ether alone, and practically coincides with it as soon as the frequency of the force is a considerable multiple of that of the molecules. In this case both the specific inductive capacity and the refractive index of the medium are the same as that of the ether, and there is consequently no refraction. Thus, the absence of refraction, instead of being in contradiction to the Röntgen rays, being a kind of light, is exactly what we should expect if the wave-length of the light were exceedingly small.

The other objection to these rays being a kind of light is that there is no very conclusive evidence of the existence of polarisation. Numerous experiments have been made on the difference between the absorption of these rays by a pair of tourmaline plates when their axes are crossed or parallel. Many observers have failed to observe any difference at all between the absorption in the two cases. Prince Galitzine and M. de Karnojitsky, by a kind of cumulative method, have obtained photographs which seem to show that there is a slightly greater absorption when the axes are crossed than there is when the axes are parallel. There can, however, be no question that the effect, if it exists at all, is exceedingly small compared with the corresponding effect for visible light. Analogy, however, leads us to expect that to get polarisation effects we must use in the case of short waves polarisers of a much finer structure than would be necessary for long ones. Thus a wire bird-cage will polarise long electrical waves, but will have no effect on visible light. Rubens and Du Bois made an instrument which would polarise the infra-red rays by winding very fine wires very close together on a framework ; this arrangement, however, was too coarse to polarise visible light. Thus, though the structure of the tour

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maline is fine enough to polarise the visible rays, it may be much too coarse to polarise the Röntgen rays if these have exceedingly small wave-lengths. As far as our knowledge of these rays extends, I think we may say that though there is no direct evidence that they are a kind of light, there are no properties of the rays which are not possessed by some variety of light.

It is clear that if the Röntgen rays are light rays their wave-lengths are of an entirely different order to those of visible light. It is, perhaps, worth notice that on the electromagnetic theory of light we might expect two different types of vibration if we suppose that the atoms in the molecule of the vibrating substance carried electrical charges. One set of vibrations would be due to the oscillations of the bodies carrying the charges, the other set to the oscillation of the charges on these bodies. The wave-length of the second set of vibrations would be commensurate with molecular dimensions. Can these vibrations be the Röntgen rays? If so, we should expect them to be damped with such rapidity as to resemble electrical impulses rather than sustained vibrations.

If we turn from the rays themselves to the effects they produce, we find that the rays alter the properties of the substances through which they are passing. This change is most apparent in the effects produced on the electrical properties of the substances. A gas, for example, while transmitting these rays is a conductor of electricity. It retains its conducting properties for some little time after the rays have ceased to pass through it, but Mr. Rutherford and I have lately found that the conductivity is destroyed if a current of electricity is sent through the Röntgenised gas. The gas in this state behaves in this respect like a very dilute solution of an electrolyte. Such a solution would cease to conduct after enough electricity had been sent through it to electrolyse all the molecules of the electrolyte. When a current is passing through a gas exposed to the rays, the current destroys and the rays produce the structure which gives conductivity to the gas; when things have reached a steady state the rate of destruction by the current must equal the rate of production by the rays. The current can thus not exceed a definite value, otherwise more of the conducting gas would be destroyed than is produced.

This explains the very characteristic feature that in the passage of electricity through gases exposed to Röntgen rays, the current, though at first proportional to the E.M.F., soon reaches a value where it is almost constant and independent of the E.M.F., and we get to a state when a tenfold increase in the E.M.F. only increases the current by a few per cent. The conductivity under the Röntgen rays varies greatly from one gas to another; the halogens and their gaseous compounds, the compounds of sulphur, and mercury vapour are among the best conductors. It is worthy of note that those gases which are the best conductors when exposed to the rays are either elements, or compounds of elements, which have in comparison with their valency very high refractive indices.

The conductivity conferred by the rays on a gas is not destroyed by a considerable rise in temperature; it is, for example, not destroyed if it be sucked through metal tubing raised to a red heat. The conductivity is, however, destroyed if the gas is made to bubble through water; it is also destroyed if the gas is forced through a plug of glass wool. This last effect seems to indicate that the structure which confers conductivity on the gas is of a very coarse kind, and we get confirmation of this from the fact that a very thin layer of gas exposed to the Röntgen rays does not conduct nearly so well as a thicker one. I think we have evidence from other sources that electrical conduction is a process that requires a considerable space—a space large enough to enclose a very large number of molecules.

Thus Koller found that the specific resistance of petroleum, turpentine, and distilled water, when determined from experiments made with very thin layers of these substances, was very much larger than when determined from experiments with thicker layers. Even in the case of metals there is evidence that the metal has to be of appreciable size if it is to conduct electricity. The theory of the scattering of light by small particles shows that, if we assume the truth of the electromagnetic theory of light, the effects should be different according as the small particles are insulators or conductors. When the small particles are non-conductors, theory and experiment concur in showing that the direction of complete polarisation for the scattered light is at right angles to the direction of the incident light, while if the small particles are conductors, theory indicates that the direction of complete polarisation makes an angle of 60deg. with the incident light. This result is not, however, confirmed by the experiments made by Prof. Threlfall on the scattering of light by very small particles of gold. He found that the gold scattered the light in just the same way as a non-conductor, giving complete polarisation at right angles to the incident light. This would seem to indicate that those very finely divided metallic particles no longer acted as conductors. Thus there seems evidence that in the case of conduction through gases, through badly conducting liquids and through metals, electric conduction is a process which requires a very considerable space and aggregations of large numbers of molecules. I have not been able to find any direct experimental evidence as to whether the same is true for electrolytes. Experiments on the resistance of thin layers of electrolytes would be of considerable interest, as, according to one widely accepted view of electrolysis conduction through electrolytes, so far from being effected by aggregations of molecules, takes place by means of the ion, a structure simpler than that of the molecule, so that if this represents the process of electrolytic conduction, there would not seem room for the occurrence of an effect which occurs with every other kind of conduction.

In this building it is only fitting that some reference should be made to the question of the movement of the ether. You are all doubtless acquainted with the heroic attempts made by Prof. Lodge to set the ether in motion, and how successfully the ether resisted them. It seems to be conclusively proved that a solid body in motion does not set in motion the ether at an appreciable distance outside it; so that if the ether is disturbed at all in such a case, the disturbance is not comparable with that produced by a solid moving through an incompressible fluid, but must be more analogous to that which would be produced by the motion through the liquid of a body of very open structure, such as a piece of wire netting, where the motion of the fluid only extends to a distance comparable with the diameter of the wire, and not with that of the piece of netting. There is another class of phenomena relating to the movement of the ether which is, I think, deserving of consideration, and that is the effect of a varying electromagnetic field in setting the ether in motion. I do not remember to have seen it pointed out that the electromagnetic theory of light implicitly assumes that the ether is not set in motion even when acted on by mechanical forces. On the electromagnetic theory of light such forces do exist, and the equations used are only applicable when the ether is at rest. Consider, for example, the case of a plane electric wave travelling through the ether. We have parallel to the wave front a varying electric polarisation, which on the theory is equivalent to a current; at right angles to this, and also in the wave front, we have a magnetic force. Now, when a current flows through a medium in a magnetic field there is a force acting on the medium at right angles to the plane, which is parallel both to the current and to the magnetic force; there will thus be a mechanical force acting on each unit volume of the ether when transmitting an electric wave, and since this force is at right angles to the current and to the magnetic force, it will be in the direction in which the wave is propagated. In the electromagnetic theory of light, however, we assume that this force does not set the ether in motion, as unless we made this assumption we should have to modify our equations, as the electromagnetic equations are not the same in a moving field as in a field at rest. In fact, a complete discussion of the transmission of electromagnetic disturbances requires a knowledge of the constitution of the ether which we do not possess. We now assume that the ether is not set in motion by an electromagnetic wave. If we do not make this assumption we must introduce into our equation quantities representing the components of the velocity of the ether, and unless we know the constitution of the ether, so as to be able to deduce these velocities from the forces acting on it, there will be in the equations of the electromagnetic field more unknown quantities than we have equations to determine. It is, therefore, a very essential point in electromagnetic theory to investigate whether or not there is any motion of the ether in a varying electromagnetic field. We have at the Cavendish Laboratory, using Prof. Lodge's arrangement of interference fringes, made some experiments to see if we could detect any movement of the ether in the neighbourhood of an electric vibrator, using the spark which starts the vibrations as the source of light. The movement of the ether, if it exists, will be oscillatory, and with an undamped vibrator the average velocity would be zero; we used, therefore, a heavily damped vibrator, with which the average velocity might be expected to be finite. The experiments are not complete, but so far the results are entirely negative. We also tried by the same method to see if we could detect any movement of the ether in the neighbourhood of a vacuum tube emitting Röntgen rays, but could not find any trace of such a movement. Prof. Threlfall, who independently tried the same experiment has, I believe, arrived at the same conclusion.

Unless the ether is immovable under the mechanical forces in a varying electromagnetic field, there are a multitude of phenomena awaiting discovery. If the ether does move, then the velocity of transmission of electrical vibrations, and therefore of light, will be affected by a steady magnetic field. Such a field, even if containing nothing but ether, will behave towards light like a crystal, and the velocity of propagation will depend upon the direction of the rays. A similar result would also hold in a steady electric field. We may hope that experiments on these and similar points may throw some light on the properties of that medium which is universal, which plays so large a part in our explanation of physical phenomena, and of which we know so little.

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Vol. XVI. of new series of "THE ELECTRICAL ENGINEER" *can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.*

THE B. A. AT LIVERPOOL.

The British Association meeting at Liverpool is in full swing. It is surprising how rapidly in this age of scientific progress new subjects of surpassing interest claim the attention of the various sections. Our readers are more interested in the physical and mechanical sections than in the others, but it must not be forgotten that when the physicists or the engineers fail to provide an exciting topic, the chemists, biologists, geographers, or economists may have their turn. This year, however, it is the turn of the physicists. The air is full of Röntgen rays. The phenomena are discussed in the sectional meetings, but perhaps more is said and opinions are more freely expressed when a group of physicists meet in social converse. Most men of repute prefer to theorise in private rather than to commit themselves in public till experimental proofs accumulate, all pointing towards one theory. It is not often, however, that a discovery of so recondite a character can be immediately utilised for the benefit of mankind. Röntgen, however, has provided the medical profession with a weapon of the greatest service, and surgeons were not slow in adopting its aid. As the president of the association remarks, Prof. O. Lodge, at Liverpool, was among the first to aid the medical men of that town in using the new discovery. Since then the exact seats of certain forms of disease of the bony structure of the body have been made clear, and no doubt as time rolls on, the use of the Röntgen ray photographic apparatus will be common to every surgeon. Naturally we look to the president of Section A to put his imprimatur upon the most probable theory to explain the new discovery; but Prof. J. J. Thomson is cautious, and while clearing the ground of many false surmises, and pointing out that these rays have properties which some form or other of light possess, he does not go so far as to say they are a form of light. We think, however, a careful investigation of this sectional president's address will show that the inwardly expressed view is that Röntgen's discovery is the discovery of a new form of light, with shorter wave-lengths and greater velocity than the forms hitherto investigated. We are glad to find so carefully expressed the view that the past failure to obtain polarisation of the Röntgen rays may be due rather to the apparatus than to the non-polarisability of the rays. Two other topics of great interest are to be found in this address. It is somewhat reassuring to hear from so eminent a professor that the standard of physical education is rising, as well as to receive the hint of danger in attempting too much. The facility to answer examination questions upon a variety of subjects is no proof of real education; and we have always feared that the craze to accept the position of a man in an examination as a proof of ability has been of late years a little over-ridden. We agree with Prof. Thomson that a thorough grounding, with the retention of youthful enthusiasm, is more likely to benefit the man and the world than the attempt to fill him up with knowledge upon every conceivable topic. Crichtons are rare. The other question to which we have referred is that relating to the ether. When

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the British Association last met at Liverpool the chair of Section A was occupied by Clerk-Maxwell. He consolidated, so to speak, the modern views respecting the ether and electricity, and even now many are only beginning to realise the depth of his insight into these branches of physics. Prof. J. J. Thomson refers to the efforts of Prof. O. Lodge to obtain motion of ether by the motion of ponderable matter, and his failure. The failure, he points out, is in accord with the late Prof. J. Clerk-Maxwell's mathematical investigations, and that if the equation there given is correct, no motion of the ether can ensue upon the motion of matter.

We shall remark upon but one other sectional address—that of Sir Douglas Fox to Section G. The president of Section G is, we think, hardly correct in his conclusions concerning electrical enterprise in England, and this arises from a mistaken comparison between what has been done in the States and what has been done here. Here we had systems of lighting and traction in full swing before the era of the electrical engineers. America had nothing of the kind, or to a very limited extent. The field to be worked there was a blank—here it was fully occupied. It is a very different thing to have to get rid of the old, before introducing the new, to the having no old to get rid of. America, in the natural order of things, was compelled to get ahead on the new lines. Much harm has been done, and will be done, from such comparisons, especially when they receive the sanction of so high an authority. We think both electric lighting and electric traction have sufficient inherent good qualities, not only to occupy an open field, but to supplant the old systems; but in the latter case the work will be more slowly performed than in the former.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

CABLES.

Sir,—Our attention has been called to a circular issued by Messrs. W. T. Glover and Co. descriptive of "Glover's patent high-conductivity lock armour," which is claimed by that firm to be their invention, and to the article in your last week's issue dealing with this cable. We give you notice that this is an infringement of the lock-coil patents which were issued to Messrs. Latch and Batchelor in 1884, which patents are the property of Messrs. George Elliot and Co., the well-known colliery owners and wire-rope makers of Westminster, Cardiff, and Newcastle-on-Tyne, who have granted us the exclusive right to use this invention in connection with electric cable work in this country.

Very large quantities of this lock cable have been made during the past 10 years for haulage and other purposes by Messrs. Elliot, and its advantages are fully appreciated by mining engineers. We have already manufactured many miles of cable under our license with lock-coil armour—in some cases the steel segments serving merely as a mechanical protection, in others the armouring being used as the return conductor; and we have no intention to allow our rights under these patents to be infringed. Our solicitors are taking the necessary steps for our protection; and we desire to give public notice that we shall take proceedings against any firm manufacturing, or against any person, company, or corporation using cables any part of which is formed of segments which, when put together, interlock so as to form a complete locked ring or shield on the cable, or otherwise infringing the patents in question.

We shall be obliged by your giving to this letter equal publicity to that given to the notice of Messrs. Glover in your last week's issue.—Yours, etc.,

T. O. Callender, Managing Director.

Callender's Cable and Construction Company, Limited,
90, Cannon-street, E.C., September 17, 1896.

THREE-PHASE MACHINERY AT THE BUDAPEST EXHIBITION.*

BY ALFRED O. DUBSKY.

There are two three-phase generators exhibited, each of 200 h.p. capacity, at 250 revolutions per minute. The distribution of the three-phase current is made at the pressure of 300 volts between two conductors, and the motors are wound directly for this voltage. One of these dynamos works at this same pressure, so its current can be used, therefore, directly for power distribution. The other generator is wound to give 3,000 volts, and several step-down transformers provide the low-tension network with current. The number of periods is always 42 per second. As even the smallest motors never have less than four poles, the highest number of revolutions at the motor shaft is only about 1,200 per minute.

Figs. 1 and 2 give two vertical sections through this generator. There are no revolving conductors, as the revolving part consists of a star wheel made of cast steel, with projecting poles composed of laminated iron. There are 10 such poles on each side of the machine. In this way the generator has two distinct armatures, each provided with an independent winding. The exciting coil is coaxial with the generator shaft, and by sending a continuous current through this coil a magnetic flux will pass through the winding of both armatures, according to the momentary positions of the projecting poles of the revolving part. These projections have a relative displacement on the two sides of the generator, and this displacement is equal to half the width of two projections. It will be quite apparent that the induced E.M.F. in the two distinct armature windings will have a relative difference of phase of exactly 90deg. By using now the well-known arrangement proposed by Mr. C. F. Scott, it is quite easy to obtain three equal E.M.F.'s with a phase difference of 120deg. For this purpose one armature is wound directly for a tension of 300 volts between its two terminals. The other armature has a number of turns 0·867 times less than the former armature, and as the sections of iron are exactly equal in both armatures, there will be an equal magnetic flux passing through the bobbins of both windings; the tensions will be, therefore, in the ratio of the number of turns. We now connect the terminal of one armature (with the smaller number of turns) to the middle of the winding of the other one, and the three remaining terminals will allow the commutation of three-phase currents.

There are great advantages to be obtained by using this arrangement. If there should be three distinct series of coils to generate the three-phase current, the machine would be far more complicated and expensive. In this way the costs of punching and the number of coils are less, for the number of poles is only twice as large as the number of the pole projections. Moreover, the crossing of the connections is completely avoided, which is a great advantage for high-tension work. Most of the three-phase generators manufactured by the different firms have just this latter fault. In the present construction the bobbins are wound quite separately and are slid on the several armature poles. They are held in their places by the use of wooden wedges; the insulation of the iron parts of the machine is made of thick sheets of micanite.

The further construction of this generator is clearly demonstrated in Figs. 1 and 2. The continuous-current exciter is connected directly on the generator shaft in such a way that the complete armature is built on a sleeve, which latter is keyed on the shaft without the use of any external bearing. This machine is driven by ropes from its steam-engine; the other mentioned three-phased generator of the same size is coupled directly to its steam-engine.

* From the *Electrical Engineer* (New York).

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All these machines work with a considerably more magnetic flux than the special lighting generators. Without changing anything in the exciting current the drop of voltage between no load and full load on motor circuits never exceeds 15 or 20 per cent., while the short-circuit current is about 4·5 to 5 times larger than the current at full load. These machines are constructed for the use of motor circuits; for lighting purposes it is always more advantageous—for reasons of security—to employ dynamos having more copper and less iron in the armature.

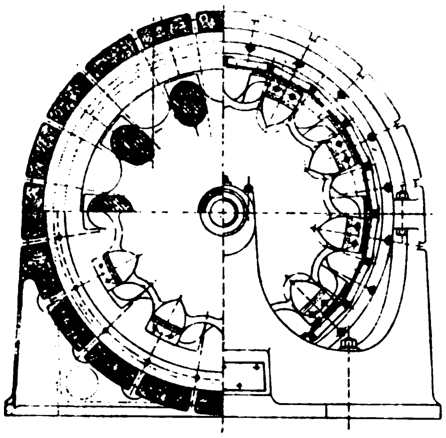

Fig. 1.

The special construction of these generators renders it possible to obtain also single-phase currents from them. One armature always generates single-phase currents, for it is only by the combination of both armatures that three-phase currents are produced. One 200-h.p. three-phase dynamo at the exhibition has been charged with 90 kilowatts in one armature, and is still employed at times to supply single-phase lighting current. Moreover, single-phase and three-phase currents can be produced at the same time by these dynamos. It would be then a true "monocyclic" installation, with the difference, that one entire armature is employed distinctly for the services of the "teaser coil."

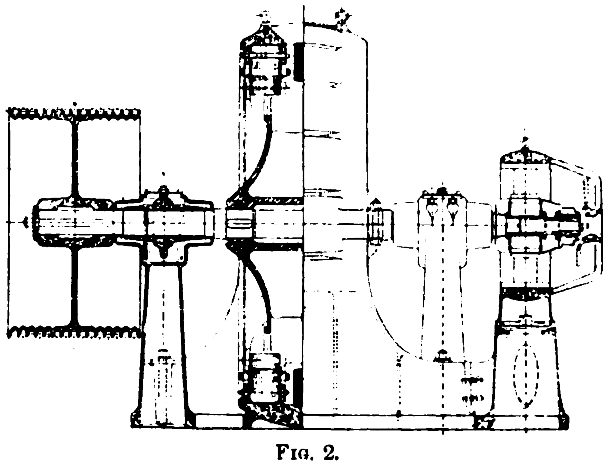

Fig. 2.

All these motors are of very different sizes. The smaller motors up to 8 h.p. have a rotor with a short-circuited armature and are switched directly on the circuit. The starting current under full load is about three times the current used when remaining at full load, and the starting torque is somewhat larger than the torque at normal running. The larger motors, those above 8 h.p., are of a different construction. In order to diminish the starting current and increase the starting torque, the inductors revolve and the induced armature is stationary, the latter having a diphase winding in order to diminish the variations of the torque in the different positions of the armature. A fluid rheostat is used to introduce large resistances during the starting, and these resistances are cut out afterwards from the circuit in proportion as the number of revolutions of the motor increases. These motors are suited to direct high-tension work, and an efficient plant is easily obtained with them.

APPLIED ELECTRO-CHEMISTRY.*

BY JAMES SWINBURNE.

LECTURE I.

Introduction.

There is probably no branch of industry which is developing so rapidly as electro-chemistry. It might have been thought that this development would have begun 10 years ago, as the electrical engineer was then quite able to provide economical steam dynamos. As a matter of fact, inventors have been working at electrolysis and electro-chemical processes for more than half a century, but a large portion of these were unpractical, as is sufficiently proved by their working out methods involving cheap electrical power when there was no prospect of such a thing. For the last 10 years or so, the applications of electricity to chemical manufacture, and to metallurgy, have engaged the attention of a great many very able people, and a still greater number of the class the Americans expressively call "cranks." A considerable time-lag was to be expected, for it takes quite 10 years for people to realise that electrical power can be developed at high efficiency and low cost. Even now the average mechanical engineer does not appreciate the value of the electric motor; so it is hardly to be expected that chemical manufacturers can yet all fully realise exactly what electrical power will do. All the same they have been by no means behindhand, and there are several large electro-chemical works already running in different parts of the world.

Some years ago the difficulty was that the average electrician knew no chemistry, and the chemist knew nothing about electricity; so that there was a sharp line between electricians and chemists. There is, however, a new state of things arising. During the last 15 years a new science may be said to have come into existence. This is chemistry on an engineering basis—that is to say, chemistry is now studied in its relation to the transformation of energy. This study demands almost a peculiar training. It requires a knowledge of mathematics and of thermo-dynamics, and mathematics is not generally a strong point among chemists. It also needs a knowledge of electricity, and of general physics, and, of course, of chemistry. The result is that what I have called engineering chemistry, or chemical energetics, is not the work of the older chemists, or physicists, but, with few very eminent exceptions, is largely in the hands of a number of comparatively young men who are not trammelled by older ideas, and who are specially fitted by their training in chemistry, physics, and mathematics to deal with this subject.

Splendid work has been recently done in physical chemistry and the theory of electrolysis in Germany, and that country has distinctly taken the lead in both theoretical and applied electro-chemistry. But the result is that there is a gradual development of two distinct classes of electro-chemist. One the purely scientific, who does not know the price of anything, and could not tell a buddle from a jigger; and the other who never heard of the Kupferferrocyanidniederschlagsmembranerscheinungen — I think that word is approximately correct. It is men of the last class that are doing the practical invention, and are getting capital and setting up factories. But the first class must not be regarded as useless. Like all purely scientific men, they are providing the raw material for the practical technologist to work up into the finished article for the use of man. It is, however, a great misfortune that the two kinds of knowledge cannot be more often combined in the same man; and the present tendency is towards more complete separation, which is to be deplored.

Electricity is being gradually applied to many branches of metallurgy, and to various process of chemical manufacture, chiefly inorganic; there are also signs of its development directly and indirectly in the manufacture of organic products. Electricity is also used as a means of getting very high temperatures in the electric furnace, and though in such cases the reaction is generally a mere reduction by carbon and not electrolysis at all, their description may be classed under electro-chemical work.

It would be clearly impossible to give any account of even the theory of electrolysis, or the practice of it alone, in four short lectures. It was, therefore, very difficult to know how to give a short course on such a subject. As experiments are an important feature in the Cantor lectures, and as the only conceivable reason for anyone's coming to a lecture—unless he has to give it—is to see experiments which he cannot see elsewhere, and which cannot very well be described in print, it seem best to show as many experiments as possible. The subject, however, does not lend itself very well to lecture demonstration, and, therefore, as many experiments as possible—especially new ones—were chosen, and the lectures were arranged and delivered very much to suit the experiments. As these would hardly read well, the printed lectures are different, and include very little of the delivered matter, being

* Cantor lectures delivered before the Society of Arts.

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practically independent. As just explained, it would be impossible to go over the whole ground even very shortly; so I will merely touch on a few points that seem to me interesting, without attempting to follow the lectures delivered, or to give any sort of general survey of the subject. Up to now, the Cantor lectures have been not only exceedingly valuable in themselves, but the lecturer has frequently changed into an author, and the series of lectures grown into a book. If it is ever my fortune to develop these lectures into a book, I shall then at least have room to give a more general account of the subject.

Cost of Energy.

In most electro-chemical manufactures the cost of energy is of cardinal importance. The cost and heating power of the coal is the most important factor. If coal is taken at 10s. a ton, and gives half an indicated horse-power hour per pound, and if the combined efficiency of the engines and dynamos is taken at 80 per cent., the coal comes out at 0·18d. per kilowatt-hour. In many places coal is much cheaper than 10s. per ton, without being anything like proportionally worse, so that 0·18d. per Board of Trade "unit" may be taken as quite liberal enough, as far as coal goes. To the cost of coal must be added labour, superintendence, oil, and waste, and the interest and depreciation on the generating plant. These can be covered with a reasonable margin by taking the cost of power as a farthing per kilowatt-hour. A great deal depends, however, on precisely what is meant by cost. A farthing per kilowatt-hour covers outlay for coal, wages, and stores, and interest and depreciation at low rates on capital and plant. If, however, an engineer were to get out an estimate for the manufacture of some chemical which was very simple, needing little more than electrolytic tanks and storage and packing, and if he found that the vats and electrolytic department cost, say, £16,000 to build and £4,000 as working capital, and that the profit after paying salaries, wages, rent, taxes, office expenses, and after paying for all energy used at the rate of a farthing a kilowatt-hour, was £2,000 a year, he would be quite wrong in saying it would pay 10 per cent. The capital in engines and dynamos must be taken into account and added to the other, bringing it up to, say, £40,000. Then to the £2,000 must be added the interest on the £20,000 in generating plant, that is included in the farthing, say £1,000. The total profit is thus £3,000 on £40,000, not £2,000 on £20,000; or 7½ per cent. instead of 10.

This example is given to show that a good deal of care is necessary in working out even the roughest estimates. The great difficulty is to know what is meant by cost in each case. If the generating plant belonged to an independent proprietor, he would not be likely to supply energy at a farthing per kilowatt-hour. He would reckon his prime cost as a little less than a farthing, and would then add on a considerable percentage to give his selling price. In central-station work the cost of energy is enormously greater. This is because the generation does not go on continuously day and night, and because the expenses of distribution and collection as well as the inconveniences of location come in. The cost of energy produced by an electric light station is thus no criterion, as the other expenses run up so enormously that the cost of coal burnt at full economical load is almost buried under a pile of incidental expenses.

Probably the greatest errors in estimating the costs of electrolytic processes are due, not to under-estimating or over-estimating the cost of electrical energy, but to not realising the expenses of handling, packing, finishing, or perhaps purifying the materials. Other things have to be considered, such as the dislike of the trade to anything new or apparently new. The word "electric" acts like magic in increasing the sale of hair-brushes, quack medicines, and a thousand and one things which have nothing to do with electricity; but these articles are mostly sold to women, or to the more ignorant classes. In commerce, on the other hand, there is an equally ignorant prejudice again anything electric. Electrically tanned leather, for example, is regarded with considerable suspicion, especially as it is somewhat lighter in colour. Even the packing should be the same as that of the goods made in the old way. Some day people may realise that electrolytically-made chemicals are often more nearly pure than others. This is already commonly understood in the case of high-conductivity copper; but then it is chiefly bought by electrical engineers.

In dealing with the cost of electrical energy, the price of coal has here been taken as the basis. There is abundance of water power, however, in many districts, and we must consider how far that may affect the question of cost of manufacture. It is only too frequently assumed that water power costs nothing, and must, therefore, give electro-chemical manufacture an enormous advantage over older processes. This is very far from the truth, however, and the economy to chemical workers of the use of water power has been enormously exaggerated. I say the economy to chemical workers advisedly, for I do not mean that it does not pay well to utilise water power, but that the advantage is to the owner of the waterfall, not to the manufacturer, except in special cases. An example will illustrate this best. Imagine a chemical district where coal is 10s. a ton, and where there is a large use of electrical power, say, for making caustic and bleach electrolytically. Imagine, also, that there is water power in the neighbourhood. If the owners of a chemical works want power, they will apply to the proprietor of the waterfalls. He will by no means make them a present of as much power as they want; on the contrary, he will charge rent; and he will charge as high a rent as he thinks he can get. The chemical makers, on the other hand, will not give a rent that will make the water power as costly as coal, but they will be guided by the least difference, so that the rent asked and obtained will be such that it costs the chemical company the same for water as for steam power. If the turbines and races which we suppose to be put down by the chemical manufacturers cost about the same as the engines and boilers, and take about the same labour and superintendence as the steam-generating plant, the rent for the water power, apart from the land for the turbine and dynamos, which is a different matter, will be approximately equal to the cost of coal for the same power. Assuming the plant to run continuously day and night, 1,000 kilowatts generated at 80 per cent. efficiency at 2lb. of coal per kilowatt-hour, coal being 10s. a ton, comes to £6,500 a year in round numbers, or £6. 10s. per kilowatt-year. A water power of, say, 10,000 kilowatts in such a place thus corresponds to a coal mine whose yearly output of coal is worth £65,000 before it is touched in the mine, and whose supply of coal is inexhaustible.

Suppose, however, that the water power is not in the chemical district at all, but in such a place as, for instance, Norway. The chemical manufacturer may be at some advantage there. The district may be inaccessible, and the establishment of works there may involve special difficulties and expense. In such a case the proprietor of the water power will not ask £6. 10s. per kilowatt-year, for he has no chance of getting that. He will eventually get some smaller rent, so that it will just pay a new concern to start in Norway rather than England. Still, it is the owner of the water power that gets the advantage from it, not the chemical manufacturer.

Whether it will pay to use water power in a given place or not depends on how far the power is an important item in the cost of manufacture. In such cases as making aluminium, carborundum, or calcium carbide, the power is by far the heaviest part of the cost of manufacture; and as carriage is a small matter is these cases, such manufactures will be the first to grow in places which have water power, but which are otherwise inconvenient. In most cases, however, the actual cost of the power is a comparatively small matter, and the inconveniences of being away from supply of raw material and coal for heating purposes, and from the market and the supply of skilled labour, make it inadvisable to use water power, even when it can be obtained at a very low rent. Cases like that of Niagara are peculiar. It seems to be the idea that an industrial centre will spring up around the Falls merely to batten on cheap power. There are not very many industries, electrical or non-electrical, in which power pays a very important part, and in most cases it would not pay to start works in a new locality, even if the power were given, as the drawbacks are serious. Thus, for example, it would not pay a cotton-spinner to start a new works in Devonshire, even if power were given him there, as he could not get operatives there, and he would be completely out of touch with his markets, both for buying and selling. In other cases, the works must be near the raw material, if it is heavy, as in the case of gold mining, or near coal, or near both, as in the case of ironworks. In the case of Niagara, it will undoubtedly pay users of electrical furnaces and makers of aluminium to take power from the supply company there rather than burn coal, as the supply company can always supply power more cheaply than it can be got from coal. Whether it would pay to go to Niagara, rather than to any other falls, depends on the terms offered.

The position of water powers is a little anomalous just at present, because things have not settled down yet. At present the water powers are not fully utilised, or anything like it; and there are very few processes in which power is the factor of paramount importance in determining the cost. At first, therefore, power can be got for such processes at nominal rents, and it is almost correct in such cases to say the power costs nothing. The farthing per kilowatt-hour, in the case of coal, however, included interest and depreciation on plant as well as labour and stores. In the case of the waterfall at a nominal rent, the interest on the capital sunk in flumes, races, turbines, and dynamos must also be taken into account. The cost of power will then come out a long way below a farthing, unless the fall of the water is very slight, and there are considerable engineering difficulties. In cases like aluminium or calcium carbide, carriage is of little importance. The bauxite or other oxide of aluminium has to be carried in any case, and if it has to go by sea or rail, it does not much matter how far it goes within reason, provided it has not to be handled on the way. The aluminium or the calcium carbide is so valuable in proportion to its weight, that the carriage of the produce to market is not worth considering. There are any number of waterfalls in the United

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States, Canada, Switzerland, and Norway which are available for processes of this nature, so it is probable that such processes will be able to obtain water power at very low rents for very many years to come.

Turning now to such cases as, for instance, making bleaching powder and caustic soda by the electrolysis of a solution of salt, the number of waterfalls available for this purpose is comparatively small. Suppose the electrolysis vats have a current efficiency of 80 per cent., and take, say, six volts per vat, the cost of energy comes out approximately £5 per ton of caustic. Of course, this cost must be allocated as to the caustic and bleaching powder, as they are not independent products. We may say £2. 10s. per ton of caustic, and £2. 10s. for 2·3 tons of bleach, or, roughly, £2. 10s. for caustic and £1 a ton for bleaching powder. Even if the whole of this were saved, it would not pay to start a works in an out-of-the-way mountain pass, where the carriage of salt, lime, and coal for finishing, and that of the finished caustic and bleach, would come to far more than £5 for each ton of caustic made. In addition to carriage, superintendence, and skilled labour are more expensive in out-of-the-way districts. The whole object of life is not to make an income ; that is only a means to an end, and a man with anything in him will not exile himself except as a temporary way of making money comparatively rapidly.

The number of water powers at the coast, or in other very accessible places is limited, and there will soon be enough taken up to raise the rent till the chemical manufacturers no longer profit appreciably by it. The result is that in the immediate future water power will not help the electro-chemist except in such cases as the electrical furnace.

At present water powers are sometimes to be got cheap, as the owners having so far got nothing for them are glad to sell outright, or to give a concession for a number of years for a certain income, rather than await the chances of high rents later on, when electro-chemistry is more developed. In other cases proprietors have already very exaggerated ideas of the value of their property, and it is impossible to deal with them. It is almost needless to add that if an electro-chemical company owns a waterfall, it is not in any better position than if it rented it. It has merely sunk some of its capital in the waterfall, and the same rent that would otherwise have to be paid should be charged against the manufacturing account, and credited to the profit account of the waterfall ownership. If the waterfall was bought cheap, owning it may be profitable, but it does not cheapen the electrolysis, as the company might just as well have let their waterfall for a fair rent and started their works in St. Helens or Kalk. It is needless to say all this is merely elementary economics. I do not carry books on economics with me on a holiday; but if I remember right, it is a simple application of Ricardo's theory of rent.

While on the subject of costs it may be as well to mention an apparent anomaly which often comes up in making estimates or designing new works. Suppose a process is to be worked which needs a large steam-generating plant, and suppose that on paper the process is capable of yielding an enormous profit, say 50 per cent., on the capital. It may be safely said that such a process, in practice, will not yield such a large profit, as all sorts of things will go wrong, and troubles will arise in unexpected quarters. Let us assume, then, that in practice even a pessimist, who knows his subject, expects a profit of 25 per cent. to be earned. Then the question arises, what sort of machinery is to be put down? As the engines are to run day and night, the efficiency of the generating plant seems of the highest importance, and the first idea is to put down high-class boilers, with automatic stokers, and triple-expansion condensing engines of the best and most modern types, on the ground that, as the engines run continuously, the saving in coal is more than equal to the interest on the extra capital sunk. It must be remembered, however, that the available capital is limited, as, however good the process appears, it is of necessity a large experiment at first. Unless, therefore, the saving by coal will pay at least the same interest on the increased capital as the process will as a whole, it will be better to spend it so as to get a larger output at a lower efficiency. In extreme cases, it may even pay to fit up second-hand marine or other engines at low cost and low efficiency. The same considerations apply to other kinds of plant. In such cases economical working is not so important as it appears at first sight, but freedom from breakdown is of course vital. Old machinery is often very safe from this point of view, if not overworked. When the process is satisfactorily started, and more capital is available, and the profits are falling towards the normal, it will pay to put in the best machinery, and to work at the highest economy, giving the plant a term of many years to repay its extra cost.

While on the subject of costs and estimates, it may be as well to point out another consideration that is frequently overlooked. An electro-chemical process is proposed which is to compete with a large existing chemical industry, and it is assumed that the price will not fall, because if it did fall a little, the chemical manufacturers would fail. The existing steady price of a chemical is such that the badly-managed concerns just make it pay, and the well-managed works make good profits. The better makers can always lower prices considerably without loss, so that a new mode of manufacture cannot command the market by being able to produce a little cheaper ; it can only oust a few of the existing manufacturers. It must be remembered that it will not pay to put down plant for a process that cannot pay interest and depreciation on that plant; but the old makers have already put down their plant, and rather than close as prices fall, it will pay them to write off the whole of their plant as worthless, or rather at its break-up value, and go on, if they make any profit on their working expenses alone, or even if they hope to do so soon. Before a new process can therefore drive an old one out of the market, its profits must at least be greater by the interest, and for some time by the depreciation of the plant engaged in the old manufacture in addition.

Theory.

But little can be said here on such a subject. For most practical purposes, electrolysis may be regarded as a convenient means of bringing about oxidation and reduction. The words oxidation and reduction are used very loosely by chemists, but the idea is generally clear enough. If we wanted to make it still clearer, we might go so far as to describe oxidation as what goes on at the anode and reduction as what takes place at the cathode. This would give a good idea of the changes meant, and the notion could then be extended to reactions which cannot be, or, at any rate, are not produced by electrolysis.

When we examine the processes employed in commercial chemical manufacture, as well as in the laboratory, we are struck by the fact that by far the largest portion are processes of oxidation and reduction. Nearly all the processes for getting metals consist of reductions. Iron oxide is reduced to get iron. The carbon is then oxidised out in the converter or on the puddling hearth, to get steel or wrought iron. Zinc sulphide is oxidised first, merely to get it into a form to which reduction is easily applicable. The reduced zinc is then again oxidised, to make white paint. The Leblanc process for making soda crystals and bleach is a maze of oxidations and reductions, with a few substitutions thrown in. The pyrite is oxidised into oxide and sulphur dioxide. There are alternate reductions and oxidations of a complicated nature going on in the acid chambers. The sulphuric acid acting on the salt is a substitution process. Generating chlorine from the muriatic acid is an oxidation and reduction process, and the absorption of chlorine by lime may be considered another case. The bleach is then sold to oxidise paper pulp, and frequently to oxidise our linen to a regrettable extent. The salt cake is reduced in the black ash revolvers, a substitution going on also, this reaction being really very complicated, and after that there is only lixiviation and crystallisation. It would weary the reader, or we might include the Weldon process as part of the system, and enumerate more oxidations and reductions. We may, however, imagine the carbonate to be reduced by carbon, to give us sodium ; and we now have a system, involving, without the Weldon process, no less than five separate oxidation and reduction processes to split salt into chlorine and sodium. Electrolysis splits fused salt into chlorine and sodium at once, without any other processes or chemicals being needed, and without any waste. The difficulties in electrolysing fused salt are so great, however, that at present the older and tremendously roundabout processes hold the field. The electrolysis of salt solution is more complicated as sodium is not obtained, and there are a number of small secondary reactions.

For many purposes, all that the electro-chemist—if such a word could be applied to such a man—wants to know is, how much of a compound is decomposed by a coulomb or an ampere-hour, and what pressure is needed. Faraday's law gives him one of the data ; the other is a different matter, as the pressure needed depends not only on the back pressure of the decomposition vat, but also on the resistance of the circuit. The resistance often depends on the current density ; for instance, if bubbles of gas are being evolved from an electrode, they insulate it, except for the thin films of liquid separating them. The result is a very high surface resistance. I have tried the effect of gradually increasing the pressure on lead plates in dilute acid. The pressure and current rise together until something like three volts is reached. The current then increases much more rapidly than the pressure, gases being given off in abundance, and between three and four volts there is a state of things in which a very small difference of pressure produces a given change of current density. The arrangement was used in connection with a resistance in a differential governor and was very sensitive. As many processes, such as electrolysis of salt solution, involve evolution of gases at the electrodes, it is important to get the most economical results. The mistake is often made in designing vats with electrodes inconveniently close together with the idea that a substantial reduction of the resistance is thus secured. When there must be evolution of gas at an electrode the majority of the resistance is at the electrodes, and it generally make little difference how far the electrodes are apart within reason.

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THE BRITISH ASSOCIATION.

Address to the Mechanical Science Section.

BY SIR DOUGLAS FOX (VICE-PRESIDENT, INSTITUTION OF CIVIL ENGINEERS), PRESIDENT OF THE SECTION.

It is rather over a quarter of a century since the British Association last held its meeting in the hospitable city of Liverpool. The intervening period has been one of unparalleled progress, both generally and locally, in the many branches of knowledge and of practical application covered by civil and mechanical engineering, and therefore rightly coming within the limits for discussion in the important section of the association in which we are specially interested. During these 25 years the railway system of the British Isles, which saw one of its earliest developments in this neighbourhood, has extended from 15,376 miles, at a capital cost of £552,680,000, to 21,174 miles, at a capital cost of £1,001,000,000. The railway system of the United States has more than trebled in the same period, and now represents a total mileage of 181,082, with a capital cost of 11,565,000,000dol. The Forth and Brooklyn, amongst bridges, the Severn and St. Gothard, amongst tunnels, the gigantic works for the water supply of towns, are some of the larger triumphs of the civil engineer; the substitution of steel for iron for so many purposes, the perfecting of the locomotive, of the marine engine, of hydraulic machinery, of gas and electric plant, those of the mechanical branch of the profession.

The city of Liverpool and its sister town of Birkenhead have witnessed wonderful changes during the period under review. Great and successful efforts have been made to improve the watergate to the noble estuary, which forms the key to the city's greatness and prosperity; constant additions have been made to the docks, which are by far the finest and most extensive in the world. The docks on the two sides of the river have been amalgamated into one great trust. In order properly to serve the vast and growing passenger and goods traffic of the port, the great railway companies have expended vast sums on the connections with the dock lines and on the provision of station accommodation, and there have been introduced, in order to facilitate intercommunication, the Mersey Railway, crossing under the river, and carrying annually nearly 10 millions of passengers, and the Liverpool Overhead Railway, traversing for six miles the whole line of docks, and already showing a traffic of 7½ millions of passengers per annum. A very complete waterside station connected with the landing-stage has been lately opened by the Dock Board in connection with the London and North-Western Railway. In addition to this, the water supply from Rivington and Vyrnwy has now been made one of the finest in the world.

The following comparative figures, kindly supplied by Mr. K. Miles Burton, may be of interest:

	1871		1895.
Population of Liverpool	493,405	...	641,000 (estimated)
Population of Birkenhead	65,971	...	109,000 (estimated)
Area of docks, Liverpool, about	236 acres		362½ acres
Area of docks, Birkenhead, about	147 acres		160 acres
	383		522½
Number of steamers using the port	7,448	...	18,429
Average tonnage of six largest vessels entering the port	2,890	...	6,822

The following figures show the importance of the local railway traffic:

	1895
Number of passenger stations within the boroughs......	58
Number of goods stations	50
Number of passengers crossing the Mersey in the 12 months (Woodside Ferry)	7,143,088
Number of passengers crossing the Mersey in the 12 months (Mersey Railway)	6,976,299

To the hydraulic engineer there are few rivers of more interest and presenting more complicated problems than the Mersey and its neighbours, the Dee and the Ribble. They all possess vast areas of sand covered at high water, but laid dry as the tide falls, and in each case the maintenance of equilibrium between the silting and scouring forces is of the greatest importance to the welfare of the trading communities upon their banks. The enclosure of portions of the areas of the respective estuaries for the purposes of the reclamation of land, or for railway or canal embankments, may thus have far-reaching effects, diminishing the volume of the tidal flow and reducing the height of tide in the upper reaches of the rivers. Some idea of the magnitude of these considerations may be derived from the fact that a spring tide in the Mersey brings in through the narrows between Birkenhead and Liverpool 710 millions of cubic yards of water to form a scouring force upon the ebb. The tidal water is heavily laden with silt, which is deposited in the docks, and, at slack water, upon the sandbanks. The former is removed by dredging, and amounts to some 1,100,000 cubic yards per annum; the latter is gradually fretted down into the channels and carried out to sea before the ebb. Whilst a considerable portion of the narrows is kept scoured, in some places right down to the sandstone rock, there is a tendency, on the Liverpool side, near the landing-stage, to silt up, a difficulty counteracted to some extent by the extensive sluicing arrangements introduced by Mr. George Fosbery Lyster, the engineer of the Mersey Docks and Harbour Board.

Very extensive and interesting operations have been carried on by the Board in connection with the bar at the mouth of the river. Dredgers specially designed for the purpose have been employed for some six years, with the result that 15,142,600 tons of sand and other dredged matter have been removed, and the available depth of water at low water increased from 11ft. to 24ft. in a channel 1,500ft. in width. Those who have made the Transatlantic passage in former years can more readily appreciate the very great advantage accruing from this great improvement. Formerly, vessels arriving off the port on a low tide had to wait for some hours for the water-level to rise sufficiently to enable them to cross the bar; the result of a large vessel lying outside, rolling in the trough of the sea with her engines stopped, was that not infrequently this proved to be the worst part of the voyage between New York and Liverpool, and passengers who had escaped the malady of sea-sickness throughout the voyage were driven to their cabins and berths within three or four hours of landing. Owing to the very successful dredging operations ships of largest size can now enter or depart from the Mersey at any state of the tide, and they are also able to run alongside the landing-stage without the intervention of a tender. Such vessels as the "Teutonic" or "Majestic," of nearly 10,000 registered tonnage, 566ft. in length, 57ft. wide, and 37ft. deep; or the still larger vessels, the "Campania" or "Lucania," of nearly 13,000 tons register, 601ft. in length, 65ft. in width, and 38ft. in depth, can be seen, on mail days, lying alongside.

Whilst the estuary of the Mersey presents a narrow entrance with a wide internal estuary, the Dee, owing to extensive reclamation of land in the upper reaches, has a wide external estuary leading to an embanked river of very limited width, up which the tide rushes with great velocity laden with silt, rising in some two hours, then, during a short time of slack water, depositing the silt, which is not removed by the ebb tide, spread over some 10 hours, and therefore having comparatively little velocity. In this case also the outer estuary shows a great tendency to silt up beyond the reach of any but the highest spring tides. The reclamation of the Ribble has not yet proceeded so far as to so seriously affect the general conditions of the estuary, but here also there is a constant tendency in the channels to shift, and the erosion which takes place when a high tide and wind combine is very remarkable. A most important improvement was introduced in 1886 by Mr. G. F. Lyster, when it was decided to raise the water-level in certain of the docks by pumping, the wharves being heightened in proportion, and half-tide basins, or locks, made use of to compensate for the difference of level.

The area of the docks so treated in Liverpool is 78 acres, whilst at Birkenhead the whole area of the docks on that side of the river, amounting to 160 acres, is so raised. The hydraulic power used in the docks is very large, the indicated horse-power of the engines amounting to 1,673 in the case of Liverpool, and 874 in that of Birkenhead; whilst the Hydraulic Power Company are supplying some 1,000 h.p. to railways and private firms. The direct-acting hydraulic lifts of the Mersey Railway have now been at work for 10 years, and through these, at St. James's Station, no less than 75,000,000 to 80,000,000 of passengers have passed with regularity and safety.

It is remarkable that whilst Great Britain led the van in the introduction of steam locomotion she has lagged in the rear as regards electric and other mechanical traction. This arose in the first instance, from mistaken legislation, which strangled electrical enterprise, which is still much hampered by the reluctance of public authorities to permit the introduction of the necessary poles and wires into towns. At the date of the latest published returns there were at work in the United States no less than 12,133 miles of electric, in addition to 599 miles of cable, tramway. Hardly a large village but has its installation, and vast have been the advantages derived from these facilities. In Brooklyn, one company alone owns and works 260 miles of overhead trolley lines. With the exception of some small tramways at Portrush, Brighton, Blackpool, South Staffordshire, Hartlepool, etc., the only examples in this country of serious attempts to apply E.M.F. to the carriage of passengers are the City and South London Railway and the Liverpool Overhead Railway, the latter being the latest constructed, and having, therefore, benefited by the experience gained upon the London line. This railway is over six miles long, a double line of the normal, or 4ft. 8½in. gauge, running on an iron viaduct for the whole length of the docks; the installation is placed for convenience of coal supply about one-third of the distance from the northern end. Particulars of this interesting work will be placed before the section, but suffice it to say that a train service of three minutes each way is readily maintained, with trains carrying 112 passengers each, at an average speed of 12 miles per hour, including stoppages at 14 intermediate stations. During the last year, as before stated, 7½ million passengers were carried, the cost of traction per train mile being 3.4d. The Hartlepool tramway is proving successful, overhead trolleys and electric traction having taken the place of a horse tramroad, which was a failure from a traffic point of view. Careful researches are being prosecuted and experiments made with the intention of reducing the excessive weight of storage batteries. If this can be effected they should prove very efficient auxiliaries, especially where, in passing through towns, underground conductors are dangerous, and overhead wires objectionable.

In connection with electric traction it is very important to reduce, if possible, the initial force required for starting from rest. Whether this will be best attained by the improvement of bearings and their better lubrication, or by the storage, for starting purposes, of a portion at least of the force absorbed by the brakes, remains to be seen, but it is a fruitful field for research and experiment. In the United States there is a very general and rapid displacement of the cable tramways by the overhead-wire electric system. The latter has many opponents, owing probably to causes which are preventible. Many accidents were caused by the

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adoption of very high-tension currents, which, on the breakage of a wire, were uncontrollable, producing lamentable results. The overhead wires were placed in the middle of the street, causing interference with the passage of fire escapes. The speed of the cars was excessive, resulting in many persons being run over. The cable system therefore found many advocates, but the result of experience is in favour of electrical traction under proper safeguards. The cable system can only compete with the electric system when a three-minute or quicker service is possible, or, say, when the receipts average £20 per mile per day; it is impossible to make up lost time in running, and the cars cannot be "backed." If anything goes wrong with the cable, the whole of the traffic is disorganised. The cost of installation is much greater than in the case of electricity, and extensions are difficult. On the other hand, electricity lends itself to the demands of a growing district, and extensions are easily effected. It satisfies more easily the growing demands on the part of the public for luxury in service and car appointment. It is less expensive in installation, and works with greater economy. By placing the wire at the side of the street, and using a current of low voltage, the objections are greatly minimised, and the cars are much more easily controlled and manipulated. In cases of breakdown these are limited to the half-mile section, and do not completely disorganise the service. Electric cars have been worked successfully on gradients of 1 in 7. The conduit slot system can be adopted with good results, provided care is taken in the design of the conduit, and allowance made for ample depth and clearance. A width of ⅝in. is now proved to be sufficient. Where, however, there are frequent turnouts, junctions, and intersecting lines, the difficulties are great and the cost excessive. The following figures represent the cost of a tramway on this system in America:

Cost of track and conduit, per mile of single track..	£5,600
Insulator, boxes, and double conductor	480
Asphalte paving on 6in. of concrete to 2ft. outside double track....	1 500
	£7,580

Complete cost of operating four miles of double track for 24 hours per day with 2½-minute service, 4·55d. per train mile (exclusive of interest, taxes, etc.). One train consists of one motorcar and one trailer.

The trains make a round trip of eight miles in one hour, with three minutes lay-off at each end. The cost of keeping the slot clean comes to about £40 per quarter, and the repairs to each plough conductor about 50s. per quarter. Attempts have been made to obviate the necessity of the slot by what is known as the closed conduit; but at present the results are not encouraging. The following figures will help to convey to the mind the great development which is taking place in America, as regards the earnings upon lines electrically equipped. They are derived from the report of the State Board of Railroad Commissioners for Massachusetts:

	1888	1894	Increase.
Net earnings per passenger carried...	·48	·78	62·5 per cent.
Net earning per car mile	2·78	4·83	73·56 ,,
Net earning per mile of road	£484	£762	57 ,,

In addition to the application of electricity for illuminating purposes and for the driving of tramcars and railways, it has also been applied successfully to the driving of machinery, cranes, lifts, tools, pumps, etc., in large factories and works. This has proved of the greatest convenience, abolishing as it does the shafting of factories, and applying to each machine the necessary power by its own separate motor; the economy resulting from this can hardly be over-estimated. It is also successfully employed in the refining of copper and in the manufacture of phosphorus, aluminium, and other metals which, before its application, were beyond the reach of commercial application. The extent of its development for chemical purposes in the future no one can foresee. It is hardly necessary to call attention to the successful manner in which the Falls of Niagara and the large falls of Switzerland and elsewhere are being harnessed and controlled for the use of man and in which horse-power by thousands is being obtained. At Niagara single units of electrical plant are installed equal to about 5,000 h.p. output. These units are destined to be utilised for any of the purposes previously suggested, and it is computed that 1 h.p. can be obtained from the river and sold for the entire year day and night continuously for the sum of £3. 2s. 6d. per annum. Electric head-lights are being adopted for locomotives in the United States. The use of compressed air and compressed gas for tractive purposes is at present in an experimental stage in this country. The latter is claimed to be the cheapest for tramway purposes, the figures given being

Single-horse cars......	5⅝d.
Electrical cars, with overhead wires..........	4½d.
Gas cars	3½d.

Combination steam and electric locomotives, gasoline, compressed-air, and hot-water motors are all being tried in the United States, but definitive results are not yet published. The first electric locomotive practically applied to hauling heavy trains was put into service on the Baltimore and Ohio Railway in 1895 to conduct the traffic through the Belt Line Tunnel. It is stated that not only was the guaranteed speed of 30 miles per hour attained, but, with the locomotive running light, it reached double that speed. On the gradient of 8 per cent. a composite train of 44 cars loaded with coal and lumber, and three ordinary locomotives—weighing altogether over 1,800 tons—was started easily and gradually to a speed of 12 miles an hour without slipping a wheel. The voltage was 625. The current recorded was at starting about 2,200 amperes, and when the train was up to speed it settled down to about 1,800 amperes. The drawbar pull was about 63 000lb. The actual working expense of this locomotive is stated to be about the same as for an ordinary goods locomotive—viz., 23 cents per engine mile.

The rapid extension of tunnel construction for railway purposes, both in towns and elsewhere, is one of the remarkable features of the period under review, and has been greatly assisted by the use of shields, with and without compressed air. This brings into considerable importance the question of mechanical ventilation. Amongst English tunnels, ventilation by fan has been applied to those under the Severn and the Mersey. The machinery for the latter is probably the most complete and most scientific application up to the present time. There are five ventilating fans, two of which are 40ft. in diameter, and 12ft. wide on the blades; two of 30ft., and 10ft. wide; and one quick-running fan of 16ft. in diameter, all of which were ably installed by Messrs. Walker Bros., of Wigan. They are arranged, when in full work, to throw 800,000 cubic feet of air per minute, and to empty the tunnel between Woodside and St. James's-street in eight minutes; but, unfortunately, it is found necessary, for financial reasons, not to work the machinery to its full capacity. The intended extension of electrical underground railways will render it necessary for those still employing steam traction either to ventilate by machinery or to substitute E M F.

Great improvements have been lately made in the details of mechanical ventilators, especially by the introduction of anti-vibration shutters and the driving by belts or ropes instead of direct from the engine. The duties now usually required for mining purposes are about 300,000 cubic feet of air per minute with a water-gauge of about 4in.; but one installation is in hand for 500,000 cubic feet of air per minute with a water-gauge of 6in. Water-gauge up to 10in. can now be obtained with fans of 15ft. diameter only. An interesting installation has been made at the Pracchia tunnel on the Florence and Bologna Railway. The length of the tunnel is 1,900 metres, or about 2,060 yards; it is for a single line, and is on a gradient of 1 in 40. When the wind was blowing in at the lower end, the steam and smoke of an ascending train travelled concurrently with the train, thus producing a state of affairs almost unimaginable except to those engaged in working the traffic. Owing to the height of the Appennines above the tunnel, ventilation shafts are impracticable; but it occurred to Signor Saccardo that by blowing air by means of a fan into the mouth of the tunnel through the annular space which exists between the inside of the tunnel arch and the outside of the traffic gauge a sufficient current might be produced to greatly ameliorate the state of things. The results have been most satisfactory, the tunnel, which was formerly almost dangerous under certain conditions of, weather being now kept cool and fresh with but a small expenditure of power.

In an age when, fortunately, more attention is paid than formerly to the well-being of the men, the precautions necessary to be observed in driving long tunnels, and especially in the use of compressed air, are receiving the consideration of engineers. In the case of the intended Simplon Tunnel, which will pierce the Alps at a point requiring a length of no less than 12½ miles, a foreign commission of engineers was entrusted by the Federal Government of Switzerland with an investigation of this amongst other questions. During the construction of the St. Gothard Tunnel, which is about 10 miles in length, the difficulties encountered were of necessity very great; the question of ventilation was not fully understood, nor was sanitary science sufficiently advanced to induce those engaged in the work to give it much attention. The results were lamentable, upwards of 600 men having lost their lives, chiefly from an insiduous internal malady not then understood. But the great financial success of this international tunnel has been so marked as to justify the proposed construction of a still longer tunnel under the Simplon. The arrangements which are to be adopted for securing the health of the employés are admirable, and will surely not only result in reducing the death rate to a minimum, but also tend to shorten the time necessary for the execution of the undertaking to one-half. The quantity of air to be forced into the workings will be 20 times greater than in previous works. Special arrangements are devised for reducing the temperature of the air by many degrees, suitable houses are to be provided for the men, with excellent arrangements for enabling them to change their mining clothes, wet with the water of the tunnel, before coming in contact with the Alpine cold. Every man will have a bath on leaving, his wet clothes will be taken care of by a custodian, and dried ready for his return to work. Suitable meals of wholesome food will be provided, and he will be compelled to rest for half an hour on emerging from the tunnel, in pleasant rooms furnished with books and papers. This may appear to some as excessive care, but kind and humane treatment of men results not only in benefit to them, but also in substantial gain to those employing; them and the endeavour of our own authorities and of Parliament to secure for our own workpeople the necessary protection for their lives and limbs in carrying out hazardous trades and employments is worthy of admiration.

The great improvements in subaqueous tunnelling can be clearly recognised from the fact that the Thames Tunnel cost £1,150 per lineal yard, whilst the Blackwall Tunnel, consisting of iron lined with concrete, and of 25ft. internal diameter, has, by means of Greathead's shield and grouting machine, been driven from shaft to shaft a distance of 754 yards for £375 per yard. Tunnels have now been successfully constructed through the most difficult strata, such as water-bearing silt, sand, and gravel, and by the use of grouting under pressure subsidence can almost entirely be avoided, thus rendering the piercing of the substrata of towns, underneath property without damaging it, a simple operation, and opening

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up to practical consideration many most important lines of communication hitherto considered out of the question. On the other hand, very little improvement has taken place in the mode of constructing tunnels in ordinary ground since the early days of railways The engineers and contractors of those days adopted systems of timbering and construction which have not been surpassed. The modern engineer is, however, greatly assisted by the possibility of using brindle bricks of great strength to resist pressure, combined with quick-setting Portland cement, by the great improvements which have taken place in pumping machinery, and by the use of the electric light during construction.

A question which is forcing itself upon the somewhat unwilling attention of our great railway companies, in consequence of the continual great increase of the population of our cities, is the pressing necessity for a substantial increase in the size of the terminal stations in the great centres of population. Many of our large terminal stations are not of sufficient capacity to be worked properly, either with regard to the welfare of the staff or to the convenience of the travelling public. Speak to station masters and inspectors on duty, when the holiday season is on, and they will tell you of the great physical strain that is produced upon them and their subordinates in endeavouring to cope with the difficulty. This, if nothing else, is a justification for the enterprise of the Manchester, Sheffield, and Lincolnshire Railway Company in providing an entirely new terminus for London. It is 30 years since the last, that of St. Pancras, was added, and during that period the population of London has increased by no less than two millions.

The discussion, both in and out of Parliament, of the proposals for light railways has developed a considerable amount of interest in the question. Experience only can prove whether they will fulfil the popular expectations. If the intended branch lines are to be of the standard gauge, with such gradients and curves as will render them suitable for the ordinary rolling-stock, they will, in many cases, not be constructed at such low mileage costs as to be likely to be remunerative at rates that would attract agricultural traffic. The public roads of this country (very different from the wide and level military roads of Northern Italy and other parts of the Continent) do not usually present facilities for their utilisation, and, once admitted, the necessity for expropriating private property, the time-honoured questions of frontage severance and interference with amenities will force their way to the front; fencing will be necessary, and, even if level crossings be allowed at public roads, special precautions will have to be taken. Much must then depend upon the regulations insisted upon by the Board of Trade. If, in consideration of a reduction in speed, relaxation of existing safeguards are permitted, much may no doubt be effected by way of feeders to existing main lines. If, on the other hand, the branches are of narrower gauge, separate equipment will be necessary, and transhipment at junctions will involve both expense and delay. It is very doubtful whether the British farmer would benefit much from short railways of other than standard gauge. He must keep horses for other purposes, and he will probably still prefer to utilise them for carting his produce to the nearest railway station of the main line or to the market town. The powers granted by the Light Railways Act, in the hands of the able commissioners appointed under the Act, cannot, however, fail to be a public boon. Special Acts of Parliament will be unnecessary, facilities will be granted, procedure simplified, some Government aid rendered, and probably the heavy burden of a parliamentary deposit will be removed.

It would seem quite probable that motorcars may offer one practical solution of the problem how best to place the farms of the country in commercial touch with the trunk railways, seaports, and market towns. They could use existing roads, could run to the farmyard or field, and receive or deliver produce at first hand. Such means of locomotion were frequently proposed towards the end of the last century, and in the early part of the present one, and it was not until the year 1840 that the victory of the railway over steam upon common roads was assured, the tractive force required being then shown to be relatively as 1 to 7. The passing of the Act of 1896, superseding those of 1861 and 1865, will undoubtedly mark the commencement of a new era in mechanical road traction. The cars, at present constructed chiefly by German and French engineers, are certainly of crude design, and leave much to be desired. They are ugly in appearance, noisy, difficult to steer, and vibrate very much with the revolutions of their engines, rising as they do to 400 per minute; those driven by oil give out offensive odours, and cannot be readily started, so that the engine runs on during short stops. There would seem to be arising here an even more important opening for the skill of our mechanical engineers than in the case of bicycles, in which wonderful industry the early steps appear also to have been foreign. It is claimed for a motorcar that it costs no more than carriage, horse, and harness; that the repairs are about the same; and that, whilst a horse, travelling 20 miles per day, represents for fodder a cost of 2d. per mile, a motorcar of 2½ h.p. will run the same distance at ½d. per mile. The highway authorities should certainly welcome the new comer, for it is estimated that two-thirds of the present wear and tear of roads is caused by horses, and one-third only by wheels.

Perhaps no invention has had so widespreading an influence on the construction of railways as the adoption of the Bessemer process for the manufacture of steel rails. This has substituted a homogeneous crystalline structure, of great strength and uniformity, for the iron rails of former years, built up by bundles of bars, and therefore liable to lamination and defective welds. The price has been reduced from the £13 per ton which iron rails once reached to £3. 15s. as a minimum for steel. There are, however, not infrequently occurring, in the experience of railway companies, the cracking and even fracture of steel rails, and the Government has lately appointed a Board of Trade Committee for the investigation incidentally of this subject, but specially of the important question of the effect of fatigue upon the crystallisation, structure, and strength of the rail. Experience proves, at any rate, that it is of great importance to remove an ample length of crop end, as fractures more frequently take place near the ends, aided by the weakening caused by bolt holes. Frequent examination by tapping, as in the case of tyres, seems, at present, the most effective safeguard. It is open to serious question whether the great rigidity of the permanent way of the leading railways of this country is an advantage. Certainly the noise is very great, more so than in other countries, and this points to severe shocks, heavy wear and tear of rails and tyres, and—especially when two heavy locomotives are run with the same train—liability to fracture. Whilst the tendency in this country and in the United States has been to gradually increase the weight of rails from 40lb. up to 100lb. per lineal yard, there are engineers who think that to decrease the rigidity of rail and fishplate, and weight of chair, and to increase the sleepers so as to arrive as nearly as possible at a continuous bearing, would result in softness and smoothness of running. The average and maximum speeds now attained by express trains would appear to have reached the limit of safety, at any rate under the existing conditions of junctions, crossover roads, and other interferences with the continuity of the rail. If higher speeds are to be sought, it would seem to be necessary to have isolated trunk lines specially arranged in all their details, free from sharp curves and severe gradients and probably worked electrically, although a speed of 100 miles per hour is claimed to have been reached by a steam locomotive in the United States.

The grain trade of the port of Liverpool has assumed very large proportions, and the system of storage in large silos has been adopted with great advantage, both as regards capital, outlay, and the cost of working per ton of grain. The Liverpool grain storage warehouses at Bootle will be open to members of the association, and there can be seen the latest development of the mechanical unloading, storing, and distribution of grain in bulk; the capacity is large, being

Warehouse No. 1,	56,000 tons	or 4,240,000 bushels;
,, ,, 2,	30,000 ,,	
Quay stores	20,000 ,,	

thus constituting this granary as one of the largest, if not the largest, in the world. The question of the pressure of grain is a very difficult one, and in constructing the brick silos, which are 12ft. across at the top, by nearly 80ft. in depth, large allowance has been made both for ordinary pressure and for possible swelling of the grain. The grain is unloaded by elevators, and then transported on bands, the result being its cooling and cleansing, as well as its storage and distribution.

The question of the early adoption in England of the metric system is of importance, not only to the engineering profession, but also to the country at large. The recommendation of the recent Royal Commission appointed for the consideration of the subject was that it should be taught at once in all schools, and that in two years' time its adoption should be compulsory; but it is much to be regretted that up to the present time nothing has been done. The slight and temporary inconvenience of having to learn the system is of no moment compared to the great assistance it would prove to the commercial and trading world; the simplification of calculations and of accounts would be hailed with delight by all so soon as they realised the advantages. England is suffering greatly in her trade with the Continent for want of it. Our foreign customers, who have now used it for many years, will not tolerate the inconvenience of the endless variety of weights and measures in use in England, and they consequently purchase their goods to a great extent from Germany rather than use our antiquated English system. It is no exaggeration to say that, with their knowledge of the metric system, they regard ours as completely obsolete and unworkable, just in the same way as we should were we to buy our corn, our wine, our steel and iron, by the hin, the ephah, or the homer, or to compute our measurements by cubit, stadium, or parasang. It behoves all who desire to see England regain her trade to use all their influence in favour of the adoption of this system, as its absence is doubtless one of the contributory causes for the loss that has taken, and is taking, place. An important argument in favour of the metric system of weights and measures is that it is adopted all over the civilised world by physicists and chemists; and it may be stated with confidence that the present international character of these sciences is largely due to this. It is interesting also to notice that the metric system is being gradually introduced into other branches of science. Anthropometric measurements made by the committees of the British Association in this country and in Canada are invariably given in metres, and a comparison with measurements made in other countries can be at once made.

The period of 25 years under review has indeed witnessed great advances, both in scientific knowledge and practical application. This progress has led to powerful yet peaceful competition between the leading nations. Both from among our cousins of the United States and from our nearer neighbours of Europe have we at this meeting the pleasure of welcoming most respected representatives. But their presence and the knowledge of the great discoveries made and colossal works carried out by them and their brother scientists and engineers, must make us of Great Britain face with increased earnestness the problem of maintaining our national position, at any rate in the forefront of all that tends towards the

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"utilisation of the great sources of power in nature for the use and convenience of man." Those English engineers who have been brought in contact with engineering thought and action in America and abroad have been impressed with the thoroughness of much of the work, the great power of organisation, and the careful reliance upon scientific principles constantly kept in view, and upon chemical and mechanical experiments carried out often upon a much more elaborate scale than in this country. This is not the place from which to discuss the questions of bounties and tariffs, which have rendered possible powerful competition for the supply of machinery and railway plant from the Continent to our own Colonies, but there is certainly need for advance all along the line of mechanical science and practice if we are to hold our own—need especially to study the mechanical requirements of the world, ever widening and advancing, and to be ready to meet them by inventive faculty first, but also by rigid adherence to sound principles of construction, to the use of materials and workmanship of the highest class, to simplicity of design and detail, and to careful adaptation of our productions to the special circumstances of the various markets. It is impossible to forecast in what direction the great advances since 1871 will be equalled and exceeded in the coming quarter of a century. Progress there will, and must be probably in increased ratio, and some at the end of that period may be able to look back upon our gathering here in Liverpool in 1896 as dealing with subjects then long since left behind in the race towards perfection. The mechanical engineer may fairly hope for still greater results in the perfection of machinery, the reduction of friction, the economical use of fuel, the substitution of oil for coal as fuel in many cases, and the mechanical treatment of many processes still dependent upon the human hand. The electrical engineer (hampered as he has been in this country by unwise and retrograde legislation) may surely look forward to a wonderful expansion in the use of that mysterious force, which he has already learned so wonderfully to control, especially in the direction of traction. The civil engineer has still great channels to bridge or tunnel, vast communities to supply with water and illuminating power, and (most probably with the assistance of the electrician) far higher speeds of locomotion to attain. He has before him vast and ever-increasing problems for the sanitary benefit of the world, and it will be for him to deal from time to time with the amazing internal traffic of great cities. China lies before him, Japan welcomes all advance, and Africa is great with opportunities for the coming engineers.

Let us see to it, then, that our rising engineers are carefully educated and prepared for these responsibilities of the future, and that our scientific brethren may be ever ready to open up for them by their researches fresh vistas of possibilities, fresh discoveries of those wonderful powers and facts of nature which man to all time will never exhaust. The Mechanical Section of the British Association has done good work in this direction in the past, and we may look forward with confidence to our younger brethren to maintain these traditions in the future.

COMPANIES' MEETINGS AND REPORTS.

BABCOCK AND WILCOX, LIMITED.

The fifth ordinary general meeting of this Company was held on Friday last at the Cannon-street Hotel, E.C., Mr. Andrew Stewart, chairman of the Company, presiding.

The **Chairman** moved the adoption of the report and accounts, a summary of which has been already given in our columns. During the financial year from July 1, 1895, till June 30, 1896, the Company had been able to pay (1) an interim dividend for the half-year ended December 31, 1895, at the rate of 6 per cent. on the preference shares, and a dividend of 5 per cent. on the ordinary shares, amounting to £10,000. The Board now proposed to pay for the half-year ended June 30, 1896, a dividend at the rate of 6 per cent. on the preference shares, and a dividend of 10 per cent. on the ordinary shares, amounting in all to £17,000, making 15 per cent. on the ordinary shares for the year. They had placed to the reserve fund the sum of £25,000, and carried forward a balance to next year of £5,276. 14s. 3d. The arrangement between the Singer Company and the Babcock and Wilcox Company had come to an end in a friendly and agreeable way, and the Board had elected Mr. W. H. Inslee as a director on the Company, to fill the vacancy existing on the Board.

Sir William Arrol seconded the motion, which was carried, and the retiring directors and officers were re-elected.

GREAT HORSELESS CARRIAGE COMPANY, LIMITED.

The statutory general meeting of this Company was held last Friday at the Institute of Chartered Accountants, Moorgate-place, E.C., the Earl of Winchilsea (the chairman of the Company) presiding.

In the course of a long speech the **Chairman** said that the number of applications for motor carriages that had been received had reached a total of 4,000, and the applications for agencies in different parts of the world reached the very considerable total of 750. That, he thought, showed how the wind was blowing and the tide setting. Later on, referring to the motor to be employed, the Chairman said: "I think that one of the greatest boons we could confer on the travelling public would be if we could arrange something which would take the place of horses in our great towns. The choice of agencies which we have is between electricity, steam, and oil. For the present, at least, the use of electricity will probably be confined to those towns where it is possible to obtain supplies of it at a moderate price. That, of course, is the case to a great extent in London, where the electric supply companies are always very willing to supply electricity in the daytime at a more moderate price than they are at night, when there is a great demand on their plant for electric lighting purposes. With regard to oil and petroleum, I think they will probably be most used in rural districts." Lastly, the Company intended to thoroughly test all their vehicles before turning them on the market.

Mr. H. J. Lawson also spoke, and the proceedings ended with the usual vote of thanks.

SIR W. G. ARMSTRONG AND CO., LIMITED.

The annual report and balance-sheet for the year ending June 30 last has been issued. The report shows that, after deducting depreciation, and adding the balance from last year, as per the terms of the agreement, there remains a profit of £358,689. 12s. 3d. upon the year's operations. The directors propose the payment of a dividend of 2s 3d. per share on the ordinary shares, and 4 per cent. per annum on the preference shares of the Company (less income tax), of which 6d. per share and 2 per cent. respectively have already been paid as interim dividend. This leaves 1s. 9d. per share on the ordinary shares, and 2 per cent. on the preference shares now payable, and a balance of £5,709. 0s. 1d. to be carried to next year's account. In accordance with the articles of association, the following directors retire from office—viz., Lord Armstrong, Sir Andrew Noble, Admiral Albini, Mr. Cruddas, and Colonel Dyer. They are eligible, and offer themselves for re-election.

The report of the auditors, Messrs. Monkhouse, Goddard, and Co., states that the divisible profit, including the undivided balance brought forward from the previous year, amounts to £358,689. 12s. 3d., and, after deducting the interim dividend on the ordinary stock and on the preference shares, there is a balance of profit of £275,901. 0s. 1d. The depreciation written off leases, buildings, machinery, plant, etc., amounts to £90,911. 10s. for the year.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Cloetz (Germany).—Among other construction contracts tenders will be received on September 24 for about 11 miles of telephone line for the Altmark Tramways. Particulars are obtainable for one mark (1s.) from the Baubureau der Altmärkischen Kleinbahn, Cloetze.

Berlin.—The construction of an iron bridge at Gitschiner-und-Skalitzer-street in connection with the electric tramway is open for tender. Application is to the Königl. Regierungs und Baurathes Bureau, Markgrafenstrasse 94, Berlin, and the date is September 28.

Villefranche-Lauragais (France).—The Municipality of Villefranche-Lauragais (Haute-Garonne) have invited competitive plans for a public water supply and electric lighting. Prizes of 1,000fr., 500fr., and 200fr. are offered, under the usual conditions, and schemes must be sent to the Mairie by October 10.

Paris.—Tenders will be received on October 1, at the Department of Posts and Telegraphs, rue de Grenelle 103, Paris, for about 575 tons of copper wire and a quantity of copper and porcelain telegraphic stores. Application for permission to tender must be made to the Under Secretary of State immediately, so as to be received before September 20.

Odessa.—The Municipal Authorities have decided to offer for tender the electric lighting of part of the suburbs and the new prison. No date is given, and application must be made to the Municipal Delegation at Odessa, but certain particulars can be obtained at the Ministry of Commerce (bureau de renseignements commerciaux), Paris, rue de Varenne 80.

Cologne.—Tenders are required by the Municipal Authorities for the construction and working of electric tramways in the city of Cologne to an aggregate length of 20·3 kilometres (12½ miles). Specifications, plans, and particulars are obtainable for 10 marks (10s.) from der Registrateur B, des Oberbürgermeisteramt, Köln, Germany, and tenders must be in by November 6.

Madras.—Tenders are invited for the lighting by electricity of Government House, Madras, including the banqueting-hall and aide-de-camps' bungalow, and also for the lighting of Government House, Guindy, including the military secretary's bungalow. For particulars application must be made to the consulting architect to the Government, Chepank, Madras. Tenders will be opened on November 11, 1896.

Mayaguez (Puerto Rico).—The Secretary of State for Foreign Affairs has been informed by H.M. Ambassador at Madrid that the Spanish Government have invited tenders for the construction and working of a telephone system in Mayagüez, Puerto Rico. The date fixed for the consideration of tenders is October 8, and such particulars as have been received may be inspected at the Commercial Department of the Foreign Office between the hours of 11 and 6 daily.

Brussels.—Tenders will be received on October 21, at the Bourse Brussels, for installing the electric light at the Arlon Railway

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Station, including the offices and works. Particulars are obtainable at the Brussels Bourse. La Société national des chemins de fer vicinaux will receive tenders up to October 28 for the conversion of about 14½ miles of tramway in the suburbs of Charleroi into electric lines on the overhead system. Particulars are obtainable, price 1fr., from the office of the Société, Brussels, rue de la Science 26.

Edinburgh.—The Lord Provost, Magistrates, and Council are prepared to receive tenders for the wiring of the Burgh Assessments Office, High-street. Specification, forms of tender, and plans of the building can be obtained at the office of the resident electrical engineer, 5, Dewar-place, Edinburgh, on deposit of two guineas, which deposit will be returned on receipt of a bona fide tender. Tenders must be sent to the town clerk, Mr. Thomas Hunter, City Chambers, Edinburgh, not later than Tuesday, September 22.

Hull.—Pending the decision of the Town Council as to the leasing of the tramways or the working of them by the Corporation, tenders are invited for a license to temporarily work and use the tramways for one year from October 15, 1896, upon the terms and conditions embodied in the draft of an agreement, which can be obtained by application to Mr. R. Hill Dawe, town clerk, Town Hall, Hull. Tenders, stating the amount of rent offered, must be delivered at the Town Clerk's Office, by 10 a.m. on September 21, in sealed envelopes, endorsed "Tender for Temporary Working of Tramways."

Swansea.—The Corporation of Swansea invite tenders for: (*a*) supply and fixing of cables, casings, switch and fuse boards, and all sundry fittings and materials for installing electric light in the Swansea Market, Swansea; (*b*) supply and erection of a temporary generating plant, including gas-engine, generator, and main switchboard, together with the maintenance of the same for a period of 12 months, for the supply of electrical current to the Swansea Market, Swansea. Specifications and forms of tender and any additional information can be obtained from the engineers, Messrs. Kincaid, Waller, and Manville, of 29, Great George-street, London, S.W., on payment of £3 3s. for each specification, and same will be returned when a bona fide tender is received by the Corporation. The plan of the market can also be seen at the offices of the Engineers, or at the Guildhall, Swansea. Sealed tenders to be sent to Mr. Jno. Thomas, town clerk, endorsed "Tender for Electric Lighting Installation, Swansea Market," or "Tender for Temporary Plant for Electric Light Installation, Swansea Market," as the case may be, at or before 4 p.m. on 24th inst.

Morley.—The Electric Lighting Committee of the borough of Morley are prepared to receive tenders for the supply and erection of the following plant. (The whole bound up in one specification; price £2. 2s., returnable on receipt of a bona fide tender): Section A - Boiler-house plant: Lancashire boilers and fittings, feed pump, etc. Section B—Engine-house plant: steam alternators and exciters, motor alternator, accumulators, steam and exhaust pipes, valves, etc. Section C—switchboard and instruments. Section D—overhead crane. Section E—underground work: cables and stoneware culverts. Section F—transformers and switchboards. Section G—arc lamps, posts, and accessories. Section H—meters. Tenderers are at liberty to tender for any section, but not for part of a section. The ground plans of plant and specification, with terms and conditions of tenders and contract, may be obtained at the offices of Mr. Robert Hammond, the consulting engineer to the Corporation, Ormond House, Great Trinity-lane, London, E.C., on and after Wednesday, September 16, on payment of £2. 2s. for each copy, which sum will be refunded on the return of the specification, filled up with a bona fide tender. Tenders, sealed and marked "Tender for Electric Lighting," must be addressed to the town clerk, Mr. R. Borrough Hopkins, at the Town Hall, Morley (Yorks), and be delivered on or before Wednesday, October 14.

RESULTS OF TENDERS.

Coventry.—The City Council have accepted the tender of Messrs. W. Coates and Son, at £575, for the fitting up of an installation of the electric light at the gasworks.

Blackpool.—The tender of Mr. Simpson, Hapton, has been accepted for the electric light installation at the Primitive Methodist chapel. Mr. J. B. Thornley, Darwen and Blackpool, is the architect.

Harrogate.—The Town Council have accepted the Edison and Swan United Electric Lighting Company's tender for supplying fittings for the new baths, as under: No. 1, £297. 17s.; No. 2 (alternative), £275. 15s. 5d.

Bristol.—The Electrical Committee have received the following tenders for the additions to the central station, including piling for the foundations:

E. Walters	£23 561	0	0
J. Davis	19,930	0	0
J. Perkins	19 600	0	0
J. Durnford and Son	19,370	0	0
W. Cowlin and Son	18,940	0	0
G. H. Wilkins	18 898	0	0
A. Krauss	18,850	0	0
Wilkins and Gosling	18 557	0	0
C. A. Hayes	18,251	0	0
J. Perrott	17,750	0	0
R. Wilkins and Sons	17 471	0	0
F. Martin	16,725	12	4

It was agreed to accept the tender of Mr. F. Martin, of St. George.

Bath.—The Electric Lighting Committee have adopted Mr. Hammond's report in reference to the extension tenders. This, of course, will require to be formally confirmed by the Council. The amounts of the recommended tenders will be found in our "Business Notes."

Glasgow.—The Corporation Electric Lighting Committee have resolved to recommend the acceptance of the following offers for cables: (1) the Callender Cable and Construction Company for (*a*) 1,566 yards of 1in. cable for the sum of £961. 11s., (*b*) 2,722 yards of ½in cable at the rate of £532 per mile and (*c*) four miles of ¼in. cable for the sum of £1,360; (2) offer by the British Insulated Wire Company for 764 yards of ½in cable at the rate of £603 per mile; and (3) offer by the India Rubber, Gutta Percha, and Telegraph Works Company, Limited, for (*a*) one mile of ¼in. indiarubber cable at the rate of £368 per mile, and (*b*) two miles of potential cable at the rate of £108 per mile.

BUSINESS NOTES.

Nyack (New York).—A new electric yacht for Mr. John Jacob Astor has just been launched.

Litherland.—The District Council have decided to fix a telephone at the Council offices.

Worcester.—The new Hope-Jones electric organ in the cathedral has given great satisfaction during the musical festival.

Change of Address.—Holophane, Limited, have removed to their new showrooms and offices at 91, 93, and 95, Queen Victoria-street, London, E.C.

Huddersfield.—The Electric Light Committee report a deficiency of £116 on the half-year to June, as compared with one of £624 last year.

Penzance.—The National Telephone Company intend to establish an exchange in the borough, and have applied to the Town Council for permission to erect poles.

Royal Electric Company of Montreal.—The Bank of Montreal will pay on and after October 1 the coupons then due of the 4½ per cent. debenture loan for £154 000.

Harrow.—The electric light appears to have proved a great success, and the Electric Light and Power Company have reason to be satisfied with the result of their initial installations.

Mumbles.—An offer has been made to the District Council to light the village by electricity, but the offer was deferred. It was made by Mr. Weaver, who is laying down a plant to light his own house.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending September 13 amounted to £1,262, as compared with £1,278 in the corresponding week of the previous year, being a decrease of £16.

Competition.—It is announced that the municipal authorities propose a competition for the lighting and water supply of Cosne, in the Nièvre, France, but whether electric lighting is contemplated is not stated. The date is January 1 next.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ending September 11 were £2,388. 8s. 1d., compared with £2,048. 11s. 2d. for the corresponding period of last year, being an increase of £339. 16s. 11d.

Sheffield.—The motor deputation is visiting various towns on the Continent where motor traction is in use, and the *Sheffield Daily Telegraph* reproduces an account of every system which the deputation inspects, so the ratepayers ought to be able to come to a satisfactory decision.

Direct Spanish Telegraph Company.—The Board have decided to pay, in addition to the dividend at the rate of 10 per cent. per annum on the preference shares, an interim dividend at the rate of 4 per cent., free of income tax, on the ordinary shares, both for the half-year ended June 30.

Electrical Trades Union.—Mr. F. Sims, the organising secretary, informs us that he will address a meeting in connection with this trades union at the Club Union Buildings, Clerkenwell-road, on the evening of September 21, and another at the Horse and Groom, Charlton, on September 25.

City and South London Railway.—The returns for the week ended September 13 were £835, compared with £808 for the corresponding period of last year, being an increase of £27. The total receipts for the half-year 1896 were £10,016, compared with £9,316 last year, being an increase of £700.

Gillingham.—The offer of the electric lighting company to light parts of the district free of charge for two months was accepted at the meeting of the District Council on the suggestion of the Survey Committee. Permission was given to the company to collect the rain-water on the Gillingham-road for their use.

St. Austell.—The Highways Committee was instructed, at the last meeting of the Urban District Council, to meet the engineer of the Telephone Company with a view to arranging for the erection of the necessary poles and wires for the contemplated establishment of a telephone exchange in the town.

Windsor.—Good progress is being made with the new central station in Peascod-street for the Windsor Electrical Installation Company. The foundations have been laid of the chimney shaft, which will be 80ft. in height. The erection of the boiler-house, engine-room, and battery-room is also being proceeded with.

Wolverhampton.—At the Town Council meeting the chairman of the Lighting Committee withdrew his motion that application be made to the Local Government Board for their sanction to a loan of £670 for the purpose of sinking a well and providing pumping machinery at the generating station, Commercial-road.

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Belfast.—The work of erecting the Mater Infirmorum Hospital, Crumlin-road, is proceeding rapidly. The entire establishment will be lighted by electricity (by Messrs. Coates and Son), and advantage will be taken of the current to drive the laundry machinery, to work the hoists, and to cook in the ward kitchens.

Norden (Lancs.).—The question of lighting the road to Red Plumb was discussed at the meeting of the District Council, and it was suggested that the electric light should be used. It was, however, decided to wait till the November meeting of the County Council, when it was thought that probably something might be done for them.

Douglas.—The offices of the Southern Electric Tramway Company, which are situated at a lonely place overlooking the sea, have been broken into, and the safe, containing a considerable amount in gold and cheques, was forced and ransacked. The thieves afterwards took away the safe, weighing 3cwt., and threw it into the sea.

Southend.—At a meeting of the Town Council a letter from Messrs. Alfred Dickinson and Co., of Birmingham, stating that they were prepared, subject to receiving the sanction and support of the Council, to construct electric railways in the borough, was referred to the Land and Parliamentary Committee for consideration and report.

Morecambe.—The District Council have resolved that £26,000 be borrowed upon security of the general district rate for the purpose of defraying the expense of purchasing the plant and machinery of the Morecambe Electric Light and Power Company, Limited, according to the terms of the agreement between the Council and the company.

Ramsbottom.—The gas company recently offered their undertaking for sale to the District Council if the Council would give a price that would secure the shareholders a maximum dividend in perpetuity, but the offer was declined, and it was suggested that the Council should undertake the electric lighting forthwith, and become competitors to the gas company.

Edinburgh.—The estimates of expenditure for the ensuing year have been passed. The estimates of the Electric Lighting Committee were increased by £500, and the treasurer (Mr. McCrae) stated that the increase on the capital expenditure for electric lighting was almost £4,000, and, in fact, they would be paying this year for that account about ⅛d. per pound.

Stewart Electrical Syndicate, Limited.—This Company has been started, with a capital of £1,200, to manufacture, sell, and supply electric arc lamps, electric incandescent lamps, and electrical apparatus generally, and to carry on the business of suppliers of electricity, electricians, electrical and mechanical engineers, metal founders, etc. Registered office, 16, Paternoster-row, E.C.

Balmoral.—It is understood that arrangements are to be completed forthwith whereby it will be possible for the Court of Balmoral to be in direct telephonic communication with Whitehall and the metropolitan palaces. The new Government trunk cable between London and Aberdeen will be utilised, and all that is now required is a loop wire of low resistance from Aberdeen up Deeside.

Alderley Edge.—At the Urban District Council meeting the Clerk read a letter from the Board of Trade stating that they were prepared to consider the transfer of the provisional order when they were satisfied of the financial position of the transferee. It was resolved to forward to the Board of Trade a copy of the prospectus of the company and pointing the names of substantial gentlemen.

Bootle.—When the proceedings of the Watch Committee came up for confirmation at the Town Council meeting, Mr. Hall asked how soon the deputation which had the matter of electric lighting in hand would be able to place their report before the Council. The Mayor said the report would come before the next meeting of the Watch Committee, and would be submitted to the meeting of the Council next month.

Whitehaven.—The borough electrical engineer is preparing a report on the proposed extension of the cables to Kells. The application by the committee of the working-men's reading-room, in Duke-street, for a supply of electric current was again considered, and the engineer was instructed to report as to the probability of other customers likely to take current on the line of the proposed new main.

Ayr.—About 2,400 yards of cable have been laid in Racecourse-road and district since August 10, an average of over 100 yards per day, at approximately half the cost asked by the contractor, including the extra cost of tarring and laying the boards over the cable. It is doubtful whether the Town Council will be able to supply current to Belleisle before the races commence in that district, but every effort is being made.

Fulham.—The Electric Lighting Committee of the Vestry have considered the report of Mr. F. H Medhurst as to the advisability of the installation of electric light in the parish and the erection of a dust destructor in connection. At the outset the committee passed a resolution agreeing to apply for a provisional order under the Electric Lighting Act. This was all the business done, and no conclusion was come to in regard to Mr. Medhurst's report.

Monmouth.—The Mayor, in reply to several enquiries at the Town Council meeting, stated that as he knew the Council would be anxious to know what prospects they had of commencing the electric lighting and drainage schemes, he had written to the engineers asking them when they would be prepared to advertise for tenders, but so far he had not received a reply. The Council, he might add, would have nothing to do with it till the tenders were sent in to them.

Bristol.—At the meeting of the Electrical Committee the town clerk reported that the Local Government Board had sanctioned the raising of £75,000 on loan, repayable in 25 years. It was agreed to accept the tender of Mr. Martin, of St. George, for additions to the central station, including piling for the foundations, at £16,725. 12s. 4d. The engineer reported that the fourth large engine and alternator had been received, and were being fixed.

Levenshulme. — The Urban District Council at their last meeting adopted the minutes of the General Purposes Committee, which contained a communication from the South Manchester Electric Supply Company, announcing their intention to apply to the Board of Trade for a provisional order to supply electricity for lighting and other purposes in the district. Mr. Tunaley gave notice that at the first meeting of the Council, held next month, he would move that the Council apply to the Board of Trade for a provisional order to supply the district with electricity.

Yarmouth.—At the Town Council meeting the borough surveyor reported that since the last meeting of the Council applications had been received from two customers for 32 lamps, the total number of customers now being 186 for 9,052 lamps. He also submitted a table showing the hours of consumption at which the electric light would be used in places of worship in the town, where the officials had applied for a reduction in price. The matter was considered, and upon the recommendation of the committee the Council resolved not to make any reduction in the price at present.

Coventry.—The Local Government Board have sanctioned the borrowing by the Corporation of £13,000 for electric lighting purposes, the money to be repaid in not more than 20 years. At a meeting of the Electric Light Committee it was reported that 4,148 lamps were now connected, and that present applications for further lights would bring the total up to 5,060. There are now, as a matter of fact, more lamps connected than the smaller plant is capable of supplying. This has necessitated the use of the 200-h.p. engine, whereas hitherto the 100-h.p. has sufficed for local requirements.

Morley.—The Town Council confirmed at their last meeting the minutes of the Electric Lighting Committee, which stated that the committee had instructed Mr. Hammond to purchase necessary materials and lay the pipes or culverts in Queen street from the Bottoms to Fountain street. Specifications submitted by Mr. Hammond for the laying of mains in Queen-street were approved, and he was instructed to advertise for tenders for the carrying out of the work. The committee did not offer any objection to Mr. Hammond availing himself of Mr. Sykes's assistance in the erection of the buildings, but he (Mr. Hammond) must take all the responsibility.

Dover.—At the meeting of the Town Council a letter was read from the district manager of the National Telephone Company stating that they could not make any alteration in their charges to the Corporation, which were at present very low. They were at present engaged in making extensive alterations in the system, incurring considerable outlay, with a view to bringing the service up to date and improving it in every respect. They asked that the Council would give them the permission to place down certain poles in connection with these improvements, a request first made last June. It was decided to obtain a return showing the cost of the Corporation's instruments per year.

Pole-Finding Papers.—As a result of an incidental reference to some specimens of pole-finding papers "made in Germany" which we made in speaking of Mr. Avery's catalogue, that gentleman has sent us some specimens of pole-finding paper of his manufacture, with a request to try them on a continuous-current circuit with a pressure above two volts. This we have done, with the result that might be expected. What is more to the purpose, however, is that Mr. Avery's paper does not give the misleading results that were obtained from the German ones referred to. The fault of the latter was, not that they would not indicate "poles," but that they would find poles where they should not have done.

Cardiff.—At the meeting of the Electrical Committee of the Corporation the electrical engineer submitted three schemes for extending the electric light mains to Canton: (1) extending the electric light mains up Leckwith-road, Cowbridge-road, and Cathedral-road to a point 200 yards south of Sneyd-street, £1,600; (2) tapping a connection in Tudor-road and carrying the pipes up Clare street and Lower Cathedral-road and then New Cathedral-road to the same point, £640; (3) to join on the main at Castle-street and over Canton Bridge to the same point, about £600. On the motion of Mr. Illtyd Thomas scheme No. 1 was adopted, and it was resolved to apply to the Local Government Board for power to borrow the amount of £1,600.

Legal.—In the Vacation Court on Wednesday the case of Everitt *v.* the National Telephone Company, Limited, came before Mr. Justice Chitty. This was a motion for an order to restrain the erection of telephone poles, and counsel on both sides agreed to the continuation for a week of an injunction granted a few days before by his lordship in chambers. In the case of the Callender Bitumen Telegraph and Waterproof Company, Limited, *v.* the National Telephone Company, Limited, in which the plaintiffs moved for an order to restrain defendants from interference with the telephonic apparatus, it was mentioned that an interim injunction had been granted that day, and that the parties had therefore agreed that the motion should stand over until the second motion day at the next sittings, the defendants meanwhile giving an undertaking in the terms of the interim order.

Fareham.—In compliance with a request by Mr. Cobbett, the Urban Council agreed at their last meeting to lay the electric wires to Redlands. Mr. Abraham protested against the delays of

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the Local Government Board in settling the advance of the money needed for the purchase of the electric light wires, and said that the town seemed to be going to sleep over the matter. That night however, they had before them the question of drawing a cheque for £220 on account of loan and interest, and he would himself write to the Local Government Board on the matter. Mr. Appleby considered that it was time the officials should understand that the business of the country could not be allowed to stand still on account of holidays. On the recommendation of Mr. Manville, the Board's official adviser, it was agreed that a feed-pump for the electric works should be purchased for £9.

Armagh.—At the meeting of the County Asylum Board the report of Mr. J. Greenhill, engineer, with reference to the installation of the electric light plant and the completion of the proposed improvements in the asylum buildings was read. Mr. Greenhill stated that he had examined the tenders, three of which had been selected for the consideration of the Board. The tender of Messrs. Cooney and Swann, Belfast, was as follows: installation of electric light, including dynamo, armature, and storage battery, £985; compound engine, with 140lb. steam pressure, £313; two boilers for 100lb. pressure, £760; two feed pumps, £84—total, £2,142. The amount in the tender of Messrs. Cox Walker, of Darlington, was £1,766, and that of Messrs. Twigg and Chester, London, £1,961. After a lengthy discussion it was decided to hold a special meeting of the Board to further consider the tenders.

Southport.—A scheme is being projected for the construction of an electric tramway from Southport to Lytham, across the Ribble. The plans have been prepared by Mr. Stewart Speddy, of Hampton-road, Southport. It is proposed to build a two-line tramway on wooden piles and ironwork across the Salters' Bank. The distance to Lytham is about six or eight miles. The line would begin near the Marine-parade at Southport and end in the centre of Lytham. It is also proposed to construct a 30ft. carriageway, in addition to side walks. In order not to interfere with the navigation of the Ribble, it is proposed to have a bridge across the channel, which will be raised at the approach of a vessel. Except in mid-channel, the water is very low, and at neap tides the banks are not at all covered. In addition to the tramway, handsome erections are to be built at each end. These will consist of theatres, pavilions, ballrooms, etc.

Cheltenham.—The Town Council have adopted the minutes of the Street and Highway Committee, which we published last week, and which related to the proposed electric tramway. The minutes of the Electric Light Committee were also confirmed. Alderman Norman explained and produced plans for the lighting in the Promenade by lamps suspended at a good height over the roadway. On the occasion of his last report they had something under 100 customers and 5,500 lamps connected; but they now had 117 customers, 18 waiting connection, 8,050 lamps connected and 1,150 to be connected. He added that on the previous Saturday night they had the largest output from the works in their experience, the record being 319 units, or 25 per cent. more than on any previous occasion. Mr. Dimmer mentioned that the penny-in-the-slot apparatus for the supply of electric light was likely to be a great success.

Glasgow.—In view of the proposals for the adoption of electric traction on the tramways, the *Glasgow Herald* has published a special article designed to reassure its readers on the subject of possible dangers from electrolysis. The writer confesses a preference for a cable system, but points out that the mischiefs that have arisen in America have been simply the result of slovenly or cheap construction. Under the Board of Trade regulations they could not occur. Moreover, a complete metallic circuit might be adopted either with a conduit system or, if the inhabitants of Glasgow see no objection to overhead wires, with a double-trolley wire and two trolley poles, as is done in Cincinnati. This, however, would be more expensive and is unnecessary if the assurances of electrical experts can convince people that underground pipes are quite safe with the single-trolley wire system under the Board of Trade rules.

Halstead.—At a meeting of the Urban District Council Messrs. Crompton and Co., of Chelmsford, reported that their Mr. Jenkinson had visited Halstead, and interviewed some of the principal residents and explained to them the approximate cost of installing the electric light in the different premises, and the probable cost of using electricity for lighting, power, cooking, and heating purposes. The results of the interviews were very satisfactory, and there appeared to be a promise of something like 500 lights being taken up as soon as the supply was ready, and this, with the Council's street-lighting, would be, in the opinion of the firm, a sufficient load for a beginning, and would justify the Council in proceeding with the scheme. They gathered also that there was a possibility of customers taking current for power purposes in the daytime. The prospects generally appeared better than they had expected. The matter was referred to the committee.

Bath.—The Electric Lighting Committee have met to consider Mr. Robert Hammond's report on the tenders recently received for the extension of the electricity works about to be acquired by the Corporation. Mr. Hammond's recommendations were as follows: Boiler-house plant (Babcock boilers), Electric Construction Company, £2,462; engine-house plant (flywheel alternators), Electric Construction Company, £8,364; underground works, Callender's Cable and Construction Company (cables), £7,985, Electric Construction Company (converters), £470; overhead travelling crane, Stothert and Pitt, £350—£19,631. With regard to the arc lamps and posts, the tenders varied from £2 224 to £3,545, and Mr. Hammod recommended that each tenderer should erect a sample lamp at Bath, which, working for two months, would give the committee an opportunity of deciding for themselves which maker should secure the preference. It was unanimously decided to adopt Mr. Hammond's report in its entirety for recommendation to the Council.

Fleetwood.—Among the minutes which came up at the last meeting of the Urban District Council for confirmation were those of the Highway and Market Committee, which contained the following report: "That the committee in charge of the Fleetwood Electric Lighting Order, 1890, be authorised to confer with the promoters of the Blackpool and Fleetwood Tramroads during their negotiations in connection with the proposed transfer of the said order and to obtain details of the proposed quantity of pillars which will be required for the streets named in tramway No. 3 in order that complete designs and estimates for such pillars may be submitted to the Council at an early date." The special committee *re* electric lighting order recommended that the clerk be authorised to arrange for an interview between the members of that committee and Dr. Hopkinson, C.E., Manchester, with reference to the supply of electrical energy in the district, as per powers contained in the Blackpool and Fleetwood Tramroads Act, 1896. The minutes have been approved.

The Central London Railway.—The *Daily Mail* has lately been devoting some space to the affairs of this railway. In an interview with the secretary a few days ago, a representative of that paper elicited the following facts: "There are two tunnels, one for each train, and the risk of collision is thus practically entirely removed. Sometimes the one tunnel is on the top of the other, but it does not alter the locomotion at all. The line is being constructed on the switchback system. On leaving the station it takes a sufficient dip to give the train impetus enough to reach the next station. It is calculated that by this method the only motor power required will be in starting the train from the station, thus securing a great saving of expense, though, of course, the power is always there if there should not be sufficient impetus to have the desired effect. There is to be duplicate machinery at the generating station, to avoid the delay attendant on a breakdown. This will be the most expensive line ever built, the cost being estimated at £500,000 per mile, making a total of considerably over £3,000,000 on the whole length of 6½ miles."

Chelsea.—We extract the following from the surveyor's annual report to the Vestry: "The number of houses in Chelsea lighted by electricity for the last three years was as follows:

	1893-4.	1894-5.	1895-6.
Chelsea Electricity Supply Company ...	500 ...	598 ...	777
London Electric Supply Corporation ...	6 ...	9(?) ..	—

The Chelsea Electricity Supply Company, as now extended, have an area of supply throughout the whole of the home district of Chelsea by adding to their district the whole of the parish west of Beaufort-street. The London Electric Supply Corporation have not carried out any further extensions during the past year. I have from time to time examined the records kept by the Chelsea Electricity Supply Company, and find that they still maintain a constant pressure, and the voltmeter fixed in my office generally stands at 100 volts. As the London Electric Supply Corporation do not appear to keep a separate record for the Chelsea circuit, I have not examined their records. The upper hall of the town hall has now been fitted up with electric light."

Eccles.—The letters to the Town Council from the Local Government Board, Mr. Clirehugh, and Edmundson, Limited, on the subject of the electric lighting of the borough have been referred for discussion to the Council in committee. Mr. Clirehugh's letter asked whether the Council will now be prepared to transfer the power conferred on them by the electric lighting order to a private company in return for the out-of-pocket expenses incurred in procuring the same, and also whether in the event of his clients acquiring the powers, the Council would be prepared to grant them the concession for public lighting on similar lines to those suggested in the original scheme. It was stated that the terms on which Mr. Clirehugh's clients would be prepared to take over the electric lighting powers would include some such conditions as were agreed upon with the Altrincham District Council—namely, that the Council would be able to repurchase the order and acquire the installation on terms. Messrs. Edmundson offered to take over and carry out the provisional order upon terms to be arranged, which they stated would be favourable to Eccles.

Appointments Vacant.—The Huddersfield Electric Lighting Committee invite applications for the situation of working mechanical engineer in the electric supply station. The duties will be to keep the existing machinery in repair, connect up additional machinery, and to act generally under the instructions of the borough electrical engineer. Salary £2. 10s. per week. Applications, on foolscap paper, stating age, experience, and accompanied by copies of not more than three recent testimonials (which will not be returned), must be sent to Mr. F. C. Lloyd, town clerk, Town Hall, Huddersfield, by 21st inst., endorsed "Working Mechanical Engineer."—The London School Board require for the training ship "Shaftesbury," off Grays, a stoker mechanic, having a practical knowledge of electric lighting apparatus and steam-boilers, also capable of doing general repairs to pumps, cooking, and other apparatus. Commencing salary £50 a year (which may be increased by £2 10s. a year to £65 a year) with uniform, board, lodging, washing, and medical attendance. Applications, in candidates' own handwriting, on forms to be obtained from the School Board Offices, accompanied by copies of not more than three testimonials, must state age and previous experience, be marked outside "Stoker Mechanic," and be received by the

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Clerk of the Managers, School Board Offices, Victoria-embankment, London, W.C., by 12 noon on 22nd inst.

Electric Omnibuses.—A meeting of the London Electric Omnibus Company was held yesterday at Winchester House for the purpose of allowing a statement to be made to the proprietors by the directors as to the position and prospects of the company. There was a large attendance. The Chairman explained first of all the history of the motorcar, and quoted a House of Commons report on the subject which was published 65 years ago, and which showed that our legislators 65 years ago were very up-to-date in their opinions. He pointed out that electricity itself was quite in its infancy, for the first House of Commons report was issued as recently as 1879. The first real start in road-locomotive legislation was due to Mr. Shaw-Lefevre, who introduced the Bill into Parliament last year, and every credit is due to Sir David Salomons for his energy in bringing the matter before the public. He claimed for this company that they were the pioneer company, and he was very confident that it would meet with great success. They were beginning in a small way, and as soon as their position was assured, he was informed, they would have no difficulty in getting any amount of money they required to enlarge their undertaking. They had the most improved machinery that it was possible to obtain, and they had had built an omnibus which was the best of its kind the world had ever seen. On the previous night this omnibus was inspected by a few gentlemen at the works at Whitehall.

York.—At the meeting of the City Council Mr. Alderman Agar, chairman of the Streets and Buildings Committee, in answer to Lambert, denied that the committee had any wish to hang up the electric lighting question till after the November elections. The committee were doing what the Council wished them to do. They had applied to Prof. Kennedy to supply them with a specification. They had just lately gone over the specification and made some amendments, and tenders would be advertised for shortly. In answer to Mr. Alderman Rymer, who asked if the committee had advertised for tenders for the electric light or only intended to do so, Mr. Alderman Agar replied that the specification was in Prof Kennedy's hands, and he expected the advertisements would be issued shortly. Mr. Alderman Rymer said that he had asked his question in reference to the electric light because he believed that many of the members did not know that the committee had been given power to advertise for tenders before again coming before the Council. A little while ago he moved a resolution to the effect that no steps be taken to get tenders until the number of citizens willing to take the electric light had been ascertained. That resolution was not passed, and he now moved that the question of advertising for tenders be deferred until the citizens had had an opportunity of expressing an opinion on the electric light at the November elections. Mr. Oakley seconded. The Town Clerk advised the Lord Mayor that the resolution was out of order, and his lordship so ruled.

Bedford.—The following report of the Electric Lighting Committee was adopted at the meeting of the Town Council without discussion: "The committee have to report that the applications for additional lamps for private lighting continue to be satisfactory. Such applications represent equivalent to about 1,000 additional 8-c.p. lamps which will all be connected before the commencement of the winter months. In reference to the application for private lighting in St. Michael's-road the committee regret that owing to pressure of business they will be unable to supply the light at the present time, but they hope to take this district in hand at an early date. The committee have had under consideration the necessity of the appointment of an assistant engineer. They have received an application for the office from Mr. Hansom, who is at present employed at the Hampstead electric light works. The committee recommend that Mr. Hansom be appointed assistant to the engineer at a salary of £135 per annum. The committee have received a request from the postmaster that a lamp be placed so as to light the letter-boxes at the post office, High-street. The committee recommend that the request be acceded to. Applications have been received for the electric light for private purposes from certain residents in Lurke street and The Crescent. These streets are not included in the scheme for this year's expenditure, but the applications represent such a number of lamps as will repay the expenditure, and the committee recommend that they be empowered to proceed with the work forthwith. The engineer has been instructed to procure the additional 4in. iron pipes required for De Parys Avenue and the Embankment."

Birkenhead.—The Finance Committee reported at the Town Council meeting that they had considered the subject of the supply of electricity in the borough. It was expected that the work of laying wires and erecting electric generating stations would be completed by the middle of the month, when the illuminant would be available for consumers in the central districts of the town, where at present mains have only been laid. It had been arranged to introduce the light as soon as possible into the town hall. The standard pressure of energy in the distributing mains had been fixed at 230 volts, and consumers would be charged according to the actual quantity of energy supplied after the rate of 6d. for every unit. The minutes also included a resolution to the effect that on the termination of his present engagement, Mr. Shoolbred be appointed consulting engineer of the electrical works during the pleasure of the Council, Mr. Shoolbred undertaking to visit the works when necessary on payment of £1 for every day on which he attended. Alderman Deakin, in moving the adoption of the minutes, stated that the Corporation originally obtained power to borrow £20,000. The expenditure up to the present was £1,576 for land, and £14,440 for works and plant, making a total of about £16,000. There were various other commitments of the Corporation that would probably bring the total expenditure to something over £21,000. The expenditure, therefore, would exceed the estimate, but he hoped the excess would not be abnormal. With regard to the installation in the town hall, an expenditure of £1,500 had been sanctioned, and the expense under this head would not exceed, perhaps not reach, £1,200. On the completion of the works they would be run by the contractor for a month, and at the end of that time would be formally taken over by the Corporation.

Catalogues.—We have received from Mr. G. Braulik, of 217, Upper Thames-street, E.C., his catalogue of electrical supplies. The volume is really six catalogues bound together, each one of these relating to separate departments. Each of these has its own index, but there is no general index or list of sections, so that until one becomes familiar with the book, which is by no means a small one, it may occasionally be somewhat of a hunt to find the precise article wanted. The general principle of arrangement appears to be to take the lightest work first. Thus we begin with bells, fittings, toys, telephones, medical electric instruments, and so on to cables, dynamos, gas-engines, and the heavier matters of electric lighting. Mr. Braulik is the sole agent for Koerting and Mathiessen, and therefore one of the specialities of the catalogue is the arc lamp of that firm.—Considerations of time made it necessary to keep very short the notice of the catalogue issued by the Newton Electrical Works at Taunton. A further reference may be permitted to the diagrams and full instructions that are given for fixing and working motors. This takes up space which might have been devoted to mere advertisement of the goods of the firm, but if it results in the motors receiving fair and intelligent treatment when left in the hands of men not specially skilled in their use, it will be for the benefit of everyone, not excluding the issuers of the catalogue.—The Dynamo Brush Company, of Finsbury-pavement E.C., send us a catalogue of their new foliated rolled-metal dynamo brushes, incandescent lamps, and electric light carbons.—We have also received a price-list from the "D. P." Battery Company, Limited, which gives prices and full particulars of their storage batteries and complete batteries, renewal sections, and accessories. There is a large number of testimonials given, among which we notice the names of Mr. H. de la Rue and Mr. A. A. Campbell Swinton.

Portsmouth.—An important discussion took place at the meeting of the Town Council on the recommendation of the Tramways Committee that the Council should obtain a provisional order, so that electric traction might be introduced into the borough. Alderman Ellis, in moving the adoption of the report, pointed out that the actual cost of purchase, of reconstructing, of all the electrical gear and machinery, including cables, columns, and everything to complete the business, would not amount to more than from £110,000 to £120,000. Supposing they borrowed the money at 2½ per cent. the annual payment by them would be £6,513, but the company would pay them £7,280 a year, leaving a profit to the Corporation of £767. Supposing they could not borrow the money at less than 2¾ there would still be a net profit of £580 per annum. With the profit on the production of the current, and taking into consideration the present loss of energy they would save by working a 24 hours' load instead of 12 hours', there would be a total profit of nearly £5,000. Councillor Beale seconded without comment. Mr. Gieve moved the following amendment: "That the Tramway Committee be instructed to bring up a full report of the whole question of tramways, such report to be considered at a special meeting of this Council." He believed everybody in that chamber who had had an opportunity of seeing electric traction would agree that it was the traction of the future. The question arose, however, whether it was desirable to proceed with the application for a provisional order, or first thoroughly thrash out the various schemes of electric traction. He had been informed that if the resolution was passed, and application made immediately for a provisional order, it would follow that on December 23 next the Council would have to file a provisional agreement with the Board of Trade. He asked whether the Council thought three months was a sufficient time to thoroughly thrash out the facts and the circumstances that would have to be enquired into in connection with the question. Mr. Kimber seconded the amendment. He was not against buying the tramways, but against buying them without proper investigation. The Council had the power to acquire the tramways in sections, commencing in July next, and ending in 1902. If the company used electricity, and the Corporation were willing to serve them, the company must take the current from the Corporation. After further discussion Alderman Ellis withdrew the report.

Altrincham.—A special meeting of the Urban Council has been held to receive a deputation from the electric tramway company for the purpose of the deputation explaining their scheme and obtaining the assistance and sanction of the Council to the undertaking. The clerk read the communication of the syndicate proposing to lay the tramway from Stretford to near Peel Causeway. The Chairman said it was necessary for the syndicate to get the consent of the Council before going to Parliament for sanction of their scheme. Mr. Andrews, who said he represented a London syndicate who were prepared to invest £500,000 of money in the proposed tramway scheme, explained that they proposed to lay a double line of rail from Stretford through Sale and Altrincham, to Grange-lane, Bowdon, to be worked by the central pole electric system, the wire to be from 18ft. to 22ft. high, so as to allow the highest load of hay to pass under. In answer to questions, Mr. Andrews said they proposed to act as common carriers, and as

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such to convey farm produce, etc., to Manchester Market in the night, and the carriage would convey 60 passengers each, for which they would charge short penny stages, say to Sale for 2d. The present was only part of a scheme to be continued from Stretford to Chorlton-cum-Hardy, Withington, Didsbury, Heaton, Mersey, Stockport, Heaton Norris, etc., so as to allow of people travelling to any of these townships without going into Manchester. In answer to Mr. Vernon, he said they would be able to supply electricity for lighting purposes at 4d. or probably 3d. per Board of Trade unit, because instead of using the engines 16 hours a day to supply electricity to the consumers as at present for about four hours' consumption, the same use of the engines would produce for the 16 hours' consumption. They proposed to put a 32-c.p. lamp on each pole, and so light the streets along which they ran, but these were all questions of detail that could be dealt with more fully when the scheme was worked out. At the present all they asked was an assurance from the Council that the scheme would receive their sympathetic consideration, when they would be prepared to go on with the necessary expense to lay the scheme in legal form before them, as if such consent were withheld they would proceed no further. The syndicate would be prepared to lease the lines from the Council if they laid them down, or at a time to be fixed they would sell to the Council. The chairman (Mr. Newton) thanked Mr. Andrew for his lucid explanation of the scheme, and said the Council would give it their best consideration and communicate the result.

Brighton.—An official examination of the Brighton and Rottingdean Electric Seashore Railway was held on behalf of the Board of Trade on Saturday by Major Marindin (representing the Railway Department) and Major Cardew (representing the Electric Department). The result was of a most satisfactory character. It was low tide when the sea-going car, as it is called, started from the jetty at Brighton, there being on board Messrs. J. J. Clarke and R. J. Pope (directors of the company), Magnus Volk and St. George Moore (joint engineers), F. J. C. May (borough engineer), and J. K. Nye (solicitor of the company) Major Marindin walked in front of the car the whole of the way to Rottingdean. The car was put to some severe tests. Various obstructions were put on the rails, such as masses of timber and concrete, heaps of flint and chalk, large iron sleepers, and so on, but the car simply brushed them all aside and passed along so smoothly that a pail of water which had been placed on the back of one of the "bogies" or wheel coverings, was not upset nor was any of the water spilled. There was a large crowd of people at Rottingdean to witness the arrival of the car. Major Marindin got on board, and the car was "backed" for about a mile and brought to a standstill. Here it was allowed to stay until the tide had risen. The journey back was at length started upon, when the rails were well covered with water, the depth of which for the last half mile was over 20ft. When the jetty at Brighton was reached it was raining in torrents, but in spite of this about a thousand people had assembled to witness the return of the car. Major Cardew was then picked up, and another start for Rottingdean was made forthwith. The car again behaved in a most satisfactory manner. At Rottingdean an inspection was made of the machinery department. As it had been arranged that the car should stay at Rottingdean for the Sunday so that the residents there might have an opportunity of inspecting it, the party then "disembarked," and returned in cabs to Brighton. The inspectors expressed themselves as perfectly satisfied in every way with the new railway. There are still a few finishing touches to be put here and there, and they stated that when this had been done the certificate would be granted. The inspection was made under circumstances well calculated to severely test the safety of this novel mode of travelling, there being an equinoctial tide with a rough breeze. It is understood that the car will journey at a speed of about 5½ miles an hour at high tide, and from six to seven miles an hour when the tide is out. The engines which supply the motive power are at Rottingdean, and are of 120 h.p. Mr. Volk informs us that the railway will be opened about the end of the month, but that the car runs occasionally now.

Dundee.—At the meeting of the County Road Board of Forfarshire, Mr. A. W. Myles, the clerk, submitted a draft of the annual report to the County Council, which was agreed to. This report stated that the Board had had under consideration the remit from the last meeting of the County Council with reference to the transfer of the trunk wires from the National Telephone Company to the Post Office. In connection with this matter they had now got formal intimation from the Telephone Company terminating their agreement with the County Council as at December 23 next. Under the present arrangement, the county had been accustomed to receive from the National Telephone Company 6d. for each of 1,140 poles by way of wayleave, the sum received having been divided among the various districts according to the number of poles in each district. The county had also had an arrangement by which it had paid the company £7. 10s. for each of 12 connections with certain of the county officials' offices and police stations. As a result of the Government having taken over the inter-town trunk wires, the Telephone Company had given notice that the Post Office had now had transferred to it 860 of the poles, and that the wayleave in respect of these would cease to be paid as at December 23, 1896. After that date therefore, the county would lose the 6d. wayleave upon each of these poles. Moreover, a tariff charge of 3d. would have to be paid by the County Council to the Post Office for every county message passed over the trunk lines. On the other hand, the Telephone Company would continue to pay 6d. of wayleave upon the remaining 280 poles, and proposed to charge £7. 10s. as before for each connection. As the law stood, the Post Office could not make any payment for wayleave, and had no power to make any arrangement reducing the tariff below 3d. per message. It followed that in any arrangement with the Post Office more satisfactory to the county the general law would require to be altered. Other counties were therefore equally interested with Forfarshire. The Board had memorialised the Postmaster-General on the subject, representing that so far as the public work of Forfarshire was concerned the telephone was largely and mainly used in the police service through connections with the company's wires in the various police stations; that police stations were exclusively used in connection with the service of the Government, being on this ground exempted from taxation, both Imperial and local; that, having this fact in view, and the desirability of continuing the use of the telephone in the police service as recommended by her Majesty's Inspector of Police for Scotland, messages on police business over the trunk wires should be exempted from the ordinary tariff rates; and craving his Grace to take the premises into consideration with the view of having the matter referred to remedied at the first opportunity. A reply had since been received from the Postmaster-General, in which his Grace the Duke of Norfolk expressed regret that it was not in his power to exempt police messages from the ordinary tariff rates

Ashton.—The following minutes of the Electric Lighting Committee were adopted at the meeting of the Town Council: "The resolution of the Market, Lighting, etc., Committee, with respect to the laying of mains for street-lighting purposes was adopted, and the list of streets and roads recommended to be handed to Mr. Clirehugh and embraced in his scheme. The town clerk forwarded copy of correspondence with the engineer to the Oldham, Ashton, etc., Tramways Company, and it was ordered that the same be entered on the minutes. The town clerk wrote: 'Referring to your letter of April 16 last, I beg to inform you that at a recent meeting the Electric Lighting Committee of the Ashton Corporation were unanimously of opinion that the Corporation should undertake to supply your company with electric power; and I was instructed to let you know that the committee fully approved of the suggestion to this effect contained in your letter; and to request you to place yourself in communication with Mr. S. V. Clirehugh, of Temple-chambers, Brazennose-street, Manchester, electrical engineer to the Corporation, with a view of devising some scheme by which the proposed supply of power may be arranged.' Mr. Stephen Sellon replied for the company that he was in communication with Mr. Clirehugh on the subject, and he had great hopes that they would be able to come to some arrangement. Mr. Clirehugh attended the meeting and presented and read his second report. In report No. 2 Mr. Clirehugh says: 'As instructed by the committee, I have been in communication with the engineer of the British Electric Traction (Pioneer) Company, Limited, who have obtained powers to construct the electric tramway between Ashton and Oldham, and have, in company with him and Mr. Garcke (the managing director), visited Hamburg for the purpose of ascertaining the methods of working the tramways in conjunction with the electric light undertaking. I find in that city the lighting company charge the tramway company 1·2d. per unit. The lighting company charge consumers of electricity for lighting purposes 10d. The fuel burnt in the generating station is brought from Cardiff, and costs 18s. per ton. The lighting company have supplied and laid the whole of the underground feeders for the traction company free of cost, and maintain the same in good condition. The average annual consumption of the tramway company is 3,000,000 units. The Ashton Tramway Company will guarantee to take a minimum supply per annum from the Corporation of 350,000 units. It would be necessary for the Corporation to provide the following plant to supply this demand: two 200-kilowatt dynamos; two 330-i.h.p steam-engines (only one of these would be run, the second being held in reserve in the event of a breakdown); the necessary switchboard and instruments; and one Lancashire boiler (30ft. by 7ft). The cost of this would, I estimate, not exceed £7,500, including the proper proportion of buildings, etc. I recommend the price to be charged the tramway company be 1½d. per unit. This equals a minimum revenue per annum of £2,200 which is equivalent to £25 per horse-power per annum for a day of 18 hours. Mr. Clirehugh makes the following estimate of cost: oil, waste, etc., £220 per annum; wages, etc., £550; repairs, etc., £190; rents, etc. £320; salaries, etc., £260—total, £1,540. Since my previous report I have gone more carefully into the question of the calorific value of the refuse, and find that considerable diversity of opinion exists regarding the amount of heat obtainable. Everybody is, however, agreed as to the minimum value, which may be expressed as follows: 1lb. of refuse, which evaporates 1lb. of water. In many cases better results are obtained, even as high as 2lb. of water evaporated per pound of refuse I have, however, in my calculations taken the minimum. Fourteen thousand tons of refuse are to be destroyed per annum. This equals, approximately, 38 tons per day. The type of engine I propose will require 20lb. of water (maximum) per horse-power per hour; 38 tons = 85 120lb., which, divided by 20, gives 3,756 horse-power hours per day, which, 18 hours a day, gives 207 h.p. I consider that a reasonable estimate of the number of lamps of 8 c.p. likely to be required in the immediate future is 10,000 Bolton, at the end of its first year, has a similar number. Oldham, at the end of its second year, has 12,000. These towns, although larger in population, have not the same scope, in my opinion, for electric lighting. Having regard, also, to the fact that public lighting is contemplated, it must be borne in mind that each arc lamp is equivalent to 20 8-c.p. incandescent lamps. It must be remembered that experience has proved that only two thirds of the maximum number of lamps connected to the mains are alight at one time. Two-thirds of 10,000 is 6,666, which is equivalent to 200 kilowatts.

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I propose, therefore, to supply two engines and dynamos, each capable of supplying 200 kilowatts, one being retained a stand-by, and one set of 50 kilowatts for supplying the day load, etc., and for driving the pumps and other power required in the works. The question of boilers and destructors I propose to make the subject of another report. There are approximately five miles of streets in which mains are to be laid.' "

PROVISIONAL PATENTS, 1896.

SEPTEMBER 7.

19729. Improvements in electric traction. Charles Herbert Gadsby, 102, Park-road, Loughborough.

19757. Improvements relating to the connection of constant-current dynamos to electric lamp circuits. William Robert Lake, 45, Southampton-buildings, Chancery-lane, London. (Charles Newbold Black, United States.) (Complete specification.)

19767. Improved methods of and means for controlling electric motors. Reginald Belfield, 322 High Holborn, London. (The Westinghouse Electric and Manufacturing Company, United States.)

SEPTEMBER 8.

19783. Improvements in electric arc lamps. Harry Nunns, Shaw Syke, Halifax.

19818. Improvements in electric heaters. John Emory Meek and H. W. Johns Manufacturing Company, 46, Lincoln's-inn-fields, London. (Complete specification.)

19821. Improvements in and relating to reflectors for electric arc, incandescent, and other kinds of lamps. Frederic Joseph Warden-Stevens, 70, Chancery-lane, London.

19822. Improvements in automatic circuit breakers The British Thomson-Houston Company, Limited, 70, Chancery-lane, London. (Edward M. Hewlett, United States.) (Complete specification.)

19870. Improvements in dynamo-electric machines and electric motors. Sidney Augustus Nash, 47, Lincoln's inn-fields London.

19871. Improvements in or connected with electric automatic regulating or controlling apparatus Alexander Bewicke Blackburn and Wilfrid L. Spence, 47, Lincoln's-inn fields, London.

19877. Improvements in connecting the plates or elements of voltaic cells and batteries. Desmond Gerald Fitzgerald, 53, Chancery-lane, London.

SEPTEMBER 9.

19894. An improved method of manufacturing permanent magnets. Francis Langham Wilder, Sulham, Reading.

19908. Improvements in reflectors for incandescent electric lamps. Frederick George Thomas, 10, St. George's-crescent, Liverpool.

19911. An apparatus for determining or ascertaining the velocity of air currents in coal mines and other situations and for other purposes by novel electrical and other means. Joseph Thompson, 110, Eldon-street, Cardiff.

SEPTEMBER 10.

20035. Improvements in electrical batteries. Denys Mathieu, 60, Queen Victoria street, London.

20061. Improvements in the manufacture of filaments for electric lamps. John Archibald Sinclair, 191, Fleet-street, London.

20062. Improvements in the manufacture of filaments for electric lamps. John Archibald Sinclair, 191, Fleet-street, London.

20077. Improvements in and relating to primary batteries. Thomas Francis Boland, Charles Jones Hubbell, and Harry Cross Hubbell, 77, Chancery-lane, London. (Complete specification.)

20079. Means for enabling the current from an alternating dynamo to be utilised for charging secondary voltaic batteries and for other purposes. Ebenezer Bland Wright, 53, Chancery-lane, London.

20086. A new or improved armature for dynamo-electric machines. G. Offermann, Norfolk House, Norfolk-street Strand, London. (Complete specification.)

SEPTEMBER 11.

20095. An improved controlling and reversing switch for electromotors and similar uses. Frederick Henry Royce and Ernest Alexander Claremont, 53, Arcade-chambers, St. Mary's-gate, Manchester. (Complete specification.)

20106. Improvements in secondary batteries. Sigmund Adolf Rosenthal, 77, Chancery-lane, London. (Stanislaus Johann von Romocki, Germany.)

20121. Improvements in overhead conductors for electric traction. John Macintosh Mackay Munro, 136, Bothwell-street, Glasgow.

SEPTEMBER 12.

20217. Improvements in electrical switches. John Henry Tucker, 128, Colmore-row, Birmingham.

20242. Improvements in appliances for rendering astatic galvanometer needles independent of disturbances by earth magnetism. Siemens Bros. and Co., Limited, 28, Southampton-buildings, Chancery-lane, London. (Siemens and Halske, Germany.)

20243. Improvements in appliances for protecting electrical measuring instruments from external influences. Siemens Bros. and Co., Limited, 28, Southampton-buildings, Chancery-lane, London. (Siemens and Halske, Germany.)

SPECIFICATIONS PUBLISHED.

1895.

15695. Electrically-propelled carriages. Clubbe and Southey.

17365. Motor vehicles for electric railways. Belfield.

17430. Methods of and means for making and breaking electric circuits. Belfield.

17529. Arc lamps and stands therefor. Mills. (Hopkins.)

18725. Electric cables. Nisbett.

18726. Electric cables. Dearlove and Nisbett.

19402. Return circuits for electric railways and tramways Heys. (Kapp.)

19442. Method of and apparatus for welding by electricity and for other operations in which intense local heat is required to be produced. Hirsch.

19605 Dynamos and the driving of same and electric motors for the driving of vehicles and machinery. Vaughan-Sherrin.

24472 Dynamo-electric machines. Fynn and Easton, Anderson and Goolden, Limited.

1896.

6925. Electrical water-level indicators for steam-boilers. Biermann

11451. Apparatus for producing musical sounds by electricity. Thompson. (Breed and Bragg.)

1152. Means for switching current applicable for electric motorcars operated by a mixed supply. Adam.

13553. Ear-pierce for telephone receivers and the like. Dubbert.

14500. Call counter suitable for telephone exchanges. Stock.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5¼-5¾
Brush Company, Ordinary	3	1-1½
—— Non. Cum., 6 per cent. Pref.	2	1¼-1¾
—— 4½ per cent. Debenture Stock	100	110-113
Central London Railway, Ordinary	10	10¼-10¾
——	2	4¼-4¾
Charing Cross and Strand	5	9¼-9¾
Chelsea Electricity Company	5	7¾-8¼
—— 4½ per cent. Debentures	100	114-117
City of London, Ordinary	10	16-17
—— 6 per cent. Cumulative Pref.	10	17½-18½
—— 5 per cent. Debenture Stock	100	132-136
City and South London Railway, Consolidated Ordinary	100	51-53
—— 4 per cent. Debenture Stock	100	136-138
—— 5 per cent. Pref. Shares	10	14¾-15¼
County of London and Brush Provincial Co., Ordinary	10	8-9
—— 6 per cent. Cum. Pref.	10	13¾-14¼
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
Edison and Swan United Ordinary	3	1¾-2¼
—— 4½ per cent. Debentures	100	103-106
Electric Construction, Limited	2	1 7/16-1 9/16x d
—— 7 per cent. Cumulative Pref.	2	2¾-3¼
Elmore's Copper Depositing	2	¾-1
Elmore's Wire Company	2	⅜-⅝
W. T. Henley's Telegraph Works, Ordinary	10	18-19
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	4-4½
—— 7 per cent. Preference	5	8½-9½
India Rubber and Gutta Percha Works	10	21½-22½
—— 4½ per cent. Debentures	100	107-110
Kensington and Knightsbridge Ordinary	5	10-10½
—— 6 per cent. Pref.	5	8¼-8¾
Liverpool Electric Supply, Ordinary	5	8-8½
Liverpool Overhead Railway	10	13¼-13¾
—— 5 per cent. Pref.	10	17¼-17¾
—— 4 per cent. Mortgage Debentures of £100	100	112½-114½
London Electric Supply	5	⅞-1⅛
Metropolitan Electric Supply	10	13-14
—— 4½ per cent. First Mortgage Debenture Stock	100	120-123
National Telephone, Ordinary	5	7¼-7¾
—— 6 per cent. Cum. First Pref.	10	17-19
—— 6 per cent. Cum. Second Pref.	10	17-19
—— 5 per cent. Non. Cum. Third Pref.	5	6⅞-7⅛
—— 3½ per cent. Deb. Stock	100	107-110
Notting Hill Company	10	12-13
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8¼-8¾
—— £4½ shares	4½	7¼-7¾
Oriental Telephone and Electric Company	1	¾-⅞
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	105-107
Southampton Electric Company	5	4¾-5¼
St. James's and Pall Mall, Ordinary	5	11½-12½
—— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	40-43
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	—	8¼-8¾
Westminster Electric Supply, Ordinary	5	11-12
Yorkshire House-to-House		7½-8

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NOTES.

Fatal Accident.—We regret to learn that Mr. Wm. Ford, a young electrician in the employ of the City of London Electric Light Company, was accidentally drowned at Lewes on Wednesday.

Electro-Harmonic Society.—We may remind our readers that the smoking concert in connection with this society takes place to-night (Friday) in the banquet-room of St. James's Hall Restaurant, Regent-street, at eight o'clock.

The Goldsmiths' Institute.—The laboratory appliances at New Cross have been improved and increased ready for the winter session, and it is announced that a special course of mathematics for electrical engineering students will be started in November if there are enough entries.

Light Railways.—It has been stated that all applications to the Light Railway Commissioners for orders authorising light railways must be made in November or May. For this year only, however, the application may be made during December, but such application must contain all the information necessary to show that the rules as to notice and advertising the application have been complied with.

A Theatre Panic.—At Rome last Friday, at the Constanzi Theatre, as the performance was approaching its end, the fusing of an electric light wire set fire to the hangings of a box in the fourth tier. There was a certain amount of panic among the audience. Some people fainted, others screamed, but the orchestra played the Italian national anthem. Nobody seems to have been hurt, and though everyone tried to quit the theatre as quickly as possible, the fire was out long before the people.

Obituary.—All interested in physical science will hear with regret of the death of Mr. Hippolyte Fizeau, which has taken place at age of 77. Mr. Fizeau will, of course, be remembered for his classical researches on the measurement of the velocity of light, not to mention his other work in physical optics and allied branches of science.—On Wednesday the death was announced at Ockbrook, Derby, of Mr. John Warwick, for over twenty-five years telegraph superintendent of the Midland Railway, and the inventor and patentee of the block system. Mr. Warwick retired from the Midland Company's service in 1879.

British Association.—Next year's meeting of the British Association is to be in Canada, at Toronto, and at the meeting of the General Committee at Liverpool Sir John Evans was nominated president. The American Association for the Advancement of Science—which is not quite so big an affair as the British—has recently met, and it was proposed there that their next year's meeting should be a purely formal one, the American Association merging itself into the British. This, however, though recommended by the committee, was not agreed to, but the date and place of the American meeting was fixed with a view to going straight on from one meeting to the other. In 1898 the British is to meet at Bristol. There was an application from Glasgow, but the northern city gracefully recognised Bristol's prior claim. The meeting for 1899 is to be held at Dover, concurrently with the meeting of the French Association at Boulogne, as we announced some time ago.

Telegraphy Without Wires.—In the discussion on Prof. J. Chunder Bose's interesting paper at Liverpool, Mr. W. H. Preece referred to the following experiments. Mr. Marconi some time ago approached the Post Office officials with respect to an invention for transmitting signals without wires. The first experiments were carried out on the top of the Post Office, St. Martin's-le-Grand. Mr. Preece could not divulge the full details of the apparatus, but a 10in. induction coil was used with a Lodge originator and a parabolic reflector. The first experiments were so successful that the apparatus was taken to Salisbury Plain, and with assistance from Mr. Kempe further trials were made. With these crude instruments, the first made by the inventor, they succeeded in transmitting signals 1¼ miles. Further experiments will shortly be made, and it may be found that these Herzian waves will eventually be exceedingly useful in certain cases.

Acetylene.—Mr. F. Clowes has been studying the behaviour of mixtures of air with gradually increased proportions of acetylene when brought into contact with flame. The proportion of acetylene was progressively increased from 1 to 82 per cent. The mixture containing 3 per cent. of acetylene was the first which was affected by contact with the flame placed either above or below. A pale-green flame slowly traversed the mixture, showing that it was feebly explosive. As the proportion of acetylene was increased, the rapidity of combustion increased, and even a small volume of the mixture gave decidedly explosive effect. When 22 per cent. of acetylene was present, the explosive combustion of the mixture was attended with a slight separation of unburnt carbon. As the proportion of acetylene was increased the separation of carbon was more marked. The limit of explosibility, as judged by the flame traversing the mixture, was reached when 81 per cent. of acetylene was present.

Advanced Evening Classes.—The councils of King's College and University College, London, have inaugurated a series of advanced courses of lectures and demonstrations of a university type for the benefit of evening students who are unable to attend the day classes which are held at these colleges. The courses will be in every respect similar to the courses held during the day. They will be delivered by the college professors, and the college laboratories will be opened to the evening students as freely as to the day students. In order to make the courses accessible to poorer students the fees will be considerably reduced, the fee for each course of 20 or 30 lectures being £1. 1s. The programme for the present session includes courses on mechanical engineering, on electrical engineering, and on practical chemistry by the professors at University College, and courses on civil engineering, on architecture, on experimental and practical physics, and on pure mathematics by the professors at King's College.

The Transformation of Tramcars.—According to the *Electrical World*, it would appear that electric traction superseded the horse so rapidly in Connecticut that old tramcars became a drug in the market, and when the trolley system was introduced in the various cities in that State the problem as to what should be done with the old cars remained unsolved until some enterprising genius suggested using them for summer cottages, "hunters' camps," lodges, etc. The public readily fell in with the idea, with the result that all the 600 old cars that went into disuse are now being utilised for these purposes. It is stated that all along the Long Island coast, from Watch Hill to Larchmont, the cars may be seen perched up by the shore. To Norwich (Connecticut) is due the idea of arranging four cars in the form of a hollow square and erecting a canvas awning in the square. One of the cars is used as the kitchen, and the others as sleeping-room, dining-room, parlour, etc. One gentleman has five cars on Block Island, which he has placed end to end like a train,

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The supply of old cars in Connecticut has thus suddenly become exhausted.

Old Weights and New Measures.—The Associated Chambers of Commerce have passed the usual resolution. It is to the effect, "That the Executive Council be requested to use every opportunity of urging upon the Government the compulsory adoption of the metric system of weights and measures." At the British Association they debated the subject, but in the Economics Section. Various ways of stretching or squeezing our old measures to fit the new were discussed. Sir F. Bramwell professed his preference for the old system he can use with such marvellous facility; other people showed that they were incapable of conceiving of "decimals" in any other way than as a degraded and hampered form of proper fractions. Naturally, therefore, they prefer the freedom of the vulgar variety of fraction and convert their decimals for calculation. It is not the only instance of a bad habit acquired at school persisting through life. Of course, the question has been really settled for the present. That which never ought to have been illegalised is to be legalised again, and the matter will then stand over for a time.

Electrical Teaching.—Mr. G. R. Peers, A.I.E.E., of Manchester, has been delivering a public lecture at the Halifax Technical School as a preliminary to a course of lectures to classes which will extend over 30 weeks. There was a fair attendance. The headmaster of the school, Mr. J. Crowther, in introducing Mr. Peers, remarked that in a place like Halifax they ought to benefit considerably by attending those classes. He also informed the audience that electrical engineering was practically in its infancy, and the subject was one that might be easily acquired. The first statement has been heard before once or twice. It is one of those things which, however true when first spoken, gets less true the longer they are repeated. As to the second, it is somewhat new, and if it is the result of personal experience, we can only congratulate Mr. Crowther on the possession of unusual ability. To some of us the path of perfection in electrical engineering seems neither short nor easy—the more one learns the more remains to know. But everybody who attends a class or a lecture is not going to be an electrical engineer—fortunately for the profession. And if only a portion of the public should manage to acquire rather less wild notions on the subject of electricity than generally prevail, they might leaven the rest, to the advantage of everyone.

Calcium Carbide Furnace.—A new form of electric furnace (the Lori patent) for the production of calcium carbide is described in *L'Elettricità*. The furnace is carbon lined, and the anode is a carbon rod coming vertically down through the top of it; the cathode is a horizontal carbon plate, and is therefore normal to the rod. Immediately under the latter the plate is pierced with a hole, which is usually closed with a carbon plug, but this can be withdrawn by a lever, and it is through this hole that the furnace is discharged of the finished product. The furnace is fed from the side through an archimedian screw, and consequently, except when the bottom plug is momentarily withdrawn to discharge it, it would be practically gas-tight. The object of this is to save the carbonic oxide, which is the other product of the reduction of the lime. The carbonic oxide is drawn off through orifices in the top of the furnace, and after being purified is stored in a gasholder. From thence it is led back into a masonry chamber surrounding the furnace and there burned so that the initial temperature of the furnace and feed is raised to as high a point as possible and the amount of heating work to be done by the current diminished. The furnace appears to have been set up at Capua, but there are no details as to its working. If all the carbonic oxide were saved, the amount would be about the same as the quantity of acetylene that can be generated from the carbide manufactured. It might be worth while under certain circumstances to save it for use, say in a gas-engine. A cheaper non-gaseous fuel would do just as well to warm up the furnace. Burned in the ordinary way the heating power of carbonic oxide is not particularly great.

Telephones and Subscribers.—The National Telephone Company is not the only one by any means that has to put up with hard words as to its service. The following statement of the influence of the telephone on the average subscriber is from the New York *Press*. The New York *Electrical Engineer* says it is exaggerated and untrue, but reprints it in full. "The telephone system, as manipulated by the American Bell Telephone Company, is not only an insolent monopoly, but is the greatest unciviliser of the age. The average man who goes to the transmitter to call up a friend or for business becomes a savage. The service in this city is so poor that he is in danger of becoming a devil. If bad language felt as hot as it sounds, our telephone subscribers would have a sure revenge against the company, inasmuch as a few well-chosen words would suffice to fuse the wires and wreck the plant." And so forth with a great deal more which we do not think it worth while to repeat. The end of it is a statement that nearly all of the local profanity is expended upon the telephone, the cable cars, and the gas monopoly. "And of these three, telephone, cable car, and gas, the worst of all is the telephone!" We had always understood that the prompt adoption and general use of the telephone was one of the things the Americans prided themselves on.

The Other Sections.—All that was done in those sections of the British Association which treat of matters coming within the proper province of the *Electrical Engineer* will be dealt with elsewhere than in these notes. But one need not attend always strictly to business, especially in September, and therefore a brief note here may be made on the doings of those other sections in which the physicist and the engineer are as mere laymen. Prof. Gaskell brought out his new theory of the relationship of the vertebrates and invertebrates. It was generally not approved. But before we discussed that we should want to know whether there was any relationship. Science knows nothing of the origin of life. But of the many improbabilities, the suggestion that it originated once only, and that all living things are descended from one original group of "cells," is surely the most improbable. What wants explaining is why the possible origins are so few. But the biologist is otherwise minded in the matter. Mr. F. Darwin discussed the problem of the ascent of sap in trees—a problem of some mechanical difficulty. Prof. Poulton insisted that the earth must be older than she looks. He successfully pitted Prof. Perry against Lord Kelvin's estimate One need not bother about estimates of the life of sun—that is so very speculative. In the end probably the physicists and the evolutionists will have to abate some of the rigidity of their laws and meet each other half-way. As for *Pithecanthropus erectus*, *alias* the "missing link," it would be better if his bones were not so scattered. He was found just where he was expected, but though he had a man-like leg his skull was simply ape-like. So it seems that he took to walking on two legs instead of four before he grew brain and became (more or less) sensible. All sorts of arguments may be started from that. Perhaps it is true—perhaps not. Lastly, in the Economics they discussed "futures" and silver. It is to be hoped that the latter subject may not

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be resumed next year in America. Fortunately no one has yet proposed to remonetise copper as well as silver. If they did, in the name of the electrical trade we should have to protest.

The Anatomy of a Steam-Engine.—We have received from Messrs. G. Philip and Son, Fleet-street, a volume, with plates, which is entitled a "Model of a Horizontal Steam-Engine." Messrs. Philip have already mapped out the interior organs of the human body, of the horse, of the ox, and of the sheep by a system of superimposed plates, and they now appear to have served the horizontal steam-engine much in the same way. The book is intended for the use of general readers and elementary engineering students, and is translated from the original of Mr. C. Volkert, of Nuremberg. Some of the letterpress, however, at the end of the book, not to mention the geometrical appendix, will prove rather tough work for the general reader who knows nothing of mechanism. Meyer's variable expansion gear is taken as the type of a variable gear. It should be thoroughly understood that the engine is treated purely from an anatomical point of view. Nothing whatever is said as to the correct dimensions of the parts, nor are such matters as variable load, initial pressure, expansion, and cylinder condensation treated of. But without some reference to these it is not possible for the general reader to have much idea of what it is all for, or why "one way of letting the steam in and out of the cylinder is better than another." He must therefore take what is said on expansive working entirely on trust. Every engine is not fitted with Meyer's gear in the same way that every sheep is fitted with the same sort of compound stomach. Nature makes no leaps, but so long as the organ does its work the mechanical engineer may alter its construction in any way he pleases—and he does so. These are inevitable difficulties when a book of this kind goes beyond the simplest and most elementary form of engine. Subject to these limitations the book is a good enough one. The plates are thoroughly well drawn and coloured, while the descriptive part appears to have been carefully done. As in the case of the rest of Messrs. Philip's publications the printing and general turn out are excellent.

Chelsea Polytechnic.—We have received a copy of the prospectus of the day and evening classes at the South-West London Polytechnic Institute in Manresa-road, S.W. The institute was opened last October, and it is stated that already about 1,400 students have used it. The work hitherto has been mainly in the evening, but after September the institute will be opened to day students in mathematics, mechanics, mechanism, architecture and building construction, drawing-office work, the workshops, electrical technology, physics, the physical and electrical laboratories, chemistry, chemical laboratory, and applied art. The hours will be from 10 a.m. to 1 p.m., and from 2 p.m. to 5 p.m., on each working-day except Saturday, when the hours will be from 10 a.m. to 1 p.m. It is intended that students should be able to go through a complete course of electrical engineering, mechanical engineering, architecture, technical chemistry, applied art, and Colonial training in two years, provided the whole day is given to the work. If only a portion of the student's time is available, the classes are so arranged that he may get through a precisely similar course in three, four, or more years, and similar courses are provided in the evening. The objects of the day classes are either to give that preparatory training which will fit students over 15 years of age for practical work in the factory or engineers' shop, or such additional education as pupils may require after leaving school before entering on a higher technical and scientific course of instruction such as is provided at the Central Technical College in Exhibition-road. Looking through the prospectus it will be seen that the electrical engineering and physics department is attended to by Mr. H. Tomlinson, with an assistant professor, three "demonstrators," and one "instructor." In view of the dispute now going on as to the training of chemical experts in this country one naturally turns to the chemistry section. Of course the prospectus can at present only tell us what the institute hopes to do. Anilines and dye-stuffs and the benzine radicle generally get shoved off to the last, as usual. But in practical work "each student will work separately . . . and the work will be suited to the particular investigation" the student is interested in. Obviously the institute will do what it can. But it must be remembered that while we have concerned ourselves with only one or two branches, the Chelsea Polytechnic is going to justify its etymology by giving instruction in ever so many trades—including home dressmaking and vegetarian cookery.

The Theory of Lectures.—It will be remembered that, when Mr. James Swinburne started to deliver four lectures on applied electro-chemistry at the Society of Arts last spring, he said pretty plainly that what he intended to do was to show a series of experiments which could not very well be described in print, and the published lectures would be something altogether different. Mr. Swinburne further made it clear that under the circumstances the less his four lectures were reported the better he would like it. Some papers accepted the intimation, others did not. The *Electrical Engineer* was quite convinced that the author knew best whether he was reportable or not. Mr. Swinburne's theory is that the only conceivable reason for anyone going to a lecture instead of reading a book is in order to see experiments which he could not see elsewhere. For a great many classes of experiment this involves the awkward corollary that the utility of a lecture varies more or less inversely with the number of the attendance. Some experiments suffer a little from being thrown on a lantern-screen and viewed from the back of the gallery. However, we do not on that account intend to quarrel with this theory of the lecture; and it would be still more ungrateful to complain of Mr. Swinburne endeavouring to adjust matters to the theory, especially since it has involved his doing double work, and giving us not only a series of experiments, but a striking discourse also. Now that the latter is being published it must indeed be admitted that it has very little in common with what was said at the Adelphi. One of the troubles of the science-trained man when he is asked to apply his knowledge to practical questions—such, for example, as the determination of the possible dividends to be earned by adopting a new process—is that he finds that he must not only know the theory and practice of his own branch of science, but something also of half a dozen others which have no theoretical connection with it. Consequently, we have the first of Mr. Swinburne's lectures on practical electro-chemistry almost entirely given over to what used to be called political economy. The value of the diffused special knowledge that exists in a district where a particular industry has been carried on for a generation is a matter that is very much overlooked. It obviously has some of the characters of the "unearned increment." The questions of who actually gets the benefit of it and who is ethically entitled to it, and whether in the name of equality you cannot tax it, would form a lovely subject for the wilder school of economists to quarrel about.

Motorcarts.—There has been a race for motor cycles from Paris to Mantes and back, a total distance of about 70 miles. The average speed was 16 miles per hour. The

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"autocar race" from Paris to Marseilles and back, which should now be in progress, is confined to steam and oil motorcarts. The British Motorcar Club is to be very much to the fore there. Major Tulloch has gone over from the British Government to investigate the working of motor-cars in France, and has been entertained at a dinner given in his honour by the Automobile Club of France. In reply to a speech made by the president of the club (Baron de Zuylen de Nyevelt), Major Tulloch admitted that England was far behind France in respect to automobilism. At this the French naturally applauded. The *Engineer*, which has given much attention to the subject, says, "it seems to be impossible, for the present at all events, to work an engine exploding oil vapour without producing a nuisance." On the whole, our contemporary believes in steam, but enumerates a formidable list of difficulties. The exhaust steam has to be got rid of by an air condenser, which is not easy to work in a small carriage; also there is the difficulty of providing ample starting power. Little is said of electricity as a motive power, not, however, because its probable value is underrated, but "because its use must be highly specialised. An electric dogcart would not meet the wants of a country doctor, simply because he could not obtain the electricity; but there is no reason why electricity might not serve very well in a butcher's cart. The charged accumulators and the joints for delivery might be put into the vehicle together. A morning's round of five or six miles performed, the exhausted batteries could be returned, and a fresh set put into the vehicle with another load of meat, and so on. A gas-engine and dynamo for charging the accumulators would be much less expensive to the butcher than the half-dozen ponies they would replace." Butchers are a courageous and enterprising race, especially in the matter of driving. It may be, therefore, that the innovation in vehicles will come from them. But we confess that, in view of the usual desire to find peril, danger, and dismay in anything novel, we should prefer that the public should make its first acquaintance with the electric cart in the hands of someone a little less dashing than the average butcher boy. Lastly, Mr. Cumming Macdona has written to the *Times*. His idea of a go-ahead place is Budapest, so being there he expected to find motorcarts running there as well as electric trams. Instead of which he found that the city authorities had suppressed them "on account of accidents." But city authorities have been known to do that sort of thing before.

Electric Concentric Cables.—Mr. J. Hetherington has contributed an article to this month's number of *Cassier's Magazine* on high-pressure concentric cables and their accessories. Mr. Hetherington had the supervision of the first concentric cables laid in London in 1890. The English practice as to concentric cables is compared with the Continental, and the importance of being absolutely certain of the water-tightness of the lead casing is insisted on. Mr. Hetherington is naturally an out-and-out advocate of the alternating current under all circumstances. It is just as convenient for near distribution, he says, as the continuous current, and "motors require little consideration in England as yet." Further, he believes that there is an unmistakable trend in English practice in the direction of high pressure and in the employment of concentric cables—lead-covered and generally armoured. As it is impossible to do anything on high-tension cables when the current is on, jointing-in and other operations "are generally done in the small hours of the morning." But "whatever the hour, there is pretty certain to be some consumer on the circuit looking for a burglar or entertaining a birthday party when the current is cut off." As there is a competition in London between high and low tension, "the complaints of consumers receive very respectful attention." The various methods of avoiding this cutting off are referred to, and the convenience of a concentric cable with the outer member at the earth's potential. After a description of the London Electric Supply Corporation's 10,000-volt mains from Deptford to London, Mr. Hetherington in summing-up says: "The cost of concentric cables is about 7 to 8 per cent. greater than two single cables of equal sectional area, both being lead-covered. The armouring generally used is much cheaper than the cast-iron pipes, being about one-fourth to one-sixth of their cost (the difference diminishing with the size of the cable), and it is doubtful if the ability to draw in and out is worth the cost of the pipe. In the writer's opinion the cost of pipes can be more economically sunk in copper at the outset, a 3in. pipe representing, in this respect, about 0·1 and a 4in. pipe about 0·15 square inch sectional area of two conductors. Where armoured cables are used it is very necessary to get in the outside section at the beginning, as the cost of laying mains is enormous in London, and often varies greatly in the different districts and parishes into which London is divided; the writer had 16 different scales of charges to deal with in as many parishes. In this instance the dearest parish for reinstatement cost, per yard run, five times as much as the cheapest, and three times the average of the 16 for similar work, the difference being almost entirely due to the different methods of the surveyors. Where the reinstating is allowed to be done by contractors it can be done at a fair profit for less than half the average vestry charges and to the vestry's satisfaction, so that, although municipal labour is a very fine thing, it is not coincident with economy where a company without voice or control in its direction has to settle the bill. In concluding, the writer may express his belief that the Deptford scheme has demonstrated that current can be generated at high pressure (some of the dynamos can work at 13,000 volts) and directly transmitted from the machines by underground concentric cables with safety and certainty to distant transforming stations, where it can be lowered in pressure to anything that may be necessary. Transformers are now at work reducing from 10,000 to 100 volts at one step."

Commercial Communications. — At the autumn meeting of the Associated Chambers of Commerce at Southampton, the subject of telephonic facilities was yet once more discussed. Mr. Massey, of Hull, moved a resolution expressing the opinion that the utility to the mercantile community of the trunk telephone cables between mercantile centres was very materially decreased owing to the great delay in securing connections, and impressing upon the Government the necessity of promptly increasing or improving the main cable connections. The motion having been seconded, Mr. Rowlett, of Leicester, expressed his woes. He complained that while up to the present he had been able to subscribe to the trunk line communication, he had received notice that after March next he would have to pay for every individual message. Another grievance he had was that the Post Office were charging one penny for every time they "called up" a correspondent who might not be at hand at the moment. This should be remedied without delay. Mr. Zossenheim, of Leeds, said we were the first commercial country in the world, yet we had the least telephonic convenience. And so forth. The motion was carried. There was also a resolution on telegraphic communication. Mr. Firth, of Heckmondwike, moved that a memorial should be presented to the Secretary for the Colonies calling his attention to the slow progress made in carrying out the request of the Ottawa convention

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for cable communication between the colonies and the mother country, and as to the subsidising of a line of fast steamers between England and Canada. Mr. Plumer seconded this. He pointed out the danger that might arise in time of war through important sections of our cable communication being the property of American owners, and then repeated the tale of how Mr. Jay Gould went into an office in the West Indies and monopolised the wire for two hours every day in the exercise of his power as a large shareholder. The resolution was carried. The result of this has been to produce a contradiction of the tale from Mr. R. T. Brown, the secretary of the West India and Panama Telegraph Company. That gentleman, in a letter to the *Times*, says he is instructed to repeat that "the story is in all essentials false; that the late Mr. Jay Gould was not a shareholder in this company; and that his messages at Trinidad took their turn with the other traffic; and that the only difference between the treatment of his telegrams and those of the public was that the usual courtesy offered by every telegraph and railway company to the directors of associated lines, of not charging for their personal messages or conveyance, was extended to him during his visit to Trinidad. Mr. Gould was a director of the Western Union Telegraph Company of New York, to which enterprise, through one of its controlled extensions, the British and other West Indian colonies granted their concessions for the establishment of the West Indian telegraph system. I may add that the whole international traffic of the West Indies does not occupy the cables in the aggregate two hours a day, while that of Trinidad can be dealt with in a few minutes. The charge of Mr. Jay Gould's being allowed to monopolise the lines is as absurd as it is untrue." The tale is one of a class which, in the intervals of abusing them, the Americans like to tell for the glorification of their millionaires. One must have some romance in life. It really has nothing to do with the question of the desirability of this country being able to depend in all cases on the integrity of its telegraphic communications with outlying parts of the Empire. After all, the question is really one of whether the available cash were best spent that way or in other directions.

Scientific Education.—We fully imagined that "Y's" letter was to finish the correspondence in the *Times* on science and technical teaching, but after a day's remission it began all over again. A German says it is the fault of the private schools, which teach nothing practical. Rather, we should say, of the parent, who is content with what they teach. Next we have a Scotsman. He is pseudonymous, and German at that, but we imagine that his name begins with N. He has studied in his own bonnie Scotland and in Germany also, and has to confess that Germany turns out the better results. Not that the raw material is better. "The first-year German student," says our Scotsman, "does not look a hopeful subject. I should venture to back for general mental fitness any odd dozen of Scotch Bejans against a similarly selected dozen of German 'Füchse.'" Nor is it English athletics. The kneipen and kater and Frühschoppen, not to mention the culture of Gambrinus, may fairly be set off against these. Nor is it the equipment of the schools. "Much of the best work of the past has in Germany been carried out in buildings whose fittings are beneath all criticism. In Prof. Ostwald's laboratory in Leipzig I was set to work in a miserable dark, damp cellar, which was, however, luxurious in the matter of water and gas compared with the rooms on the ground floor. Even some of the British municipal technical schools sneered at by 'Chemical Manufacturer' are better supplied with secondary batteries, etc., than this famous physico-chemical laboratory. In Würzburg I worked in rooms devoid of some of the most elementary conveniences of a chemical laboratory; even the few draught cupboards which existed were frauds." It is the examination system which is in fault. "There, I take it, is one of the great obstacles to our progress. Our laboratories, our professors, and our students are cancelled to inanity by the reaction of our Chinese system of examination on lazy human nature. Change the German system of granting degrees to the British method and I guarantee the bulk of the Berichte of the German chemical society will drop 75 per cent. in a couple of years. I cannot imagine the German student continuing to 'research' after the immediate necessity of it has been taken away. It is not in average student nature, be it British or German." The universities should give their degrees, not for examination results, but for research. There is probably a good deal of truth in this conclusion, but we should get at it by another train of reasoning. Richly endowed as our classics and "arts" faculties are, the work of our best and most advanced classical scholars has been largely inspired in its direction, at any rate, by the influence of German scholars. Sir B. Samuelson and the "Chemical Manufacturer" amplify what they have said before. Prof. Clifford Allbutt defends what no one attacked—namely, the high quality of the scientific teaching provided at Cambridge. There are no chemists because the manufacturer does not want them. There is a "spirit of opposition in almost all manufacturers to any introduction of scientific studies. It is not only that as a body they ignore science or shrink from the trouble of it, but also that they have a positive aversion from it; the intrusion of the scientific spirit makes them fretful and even angry. They believe this spirit to be destructive of the dexterity, smartness, and shrewdness in the affairs of the day to which they believe, and rightly believe, that their own success was due." Like master, like man—only more so. There is the British workman to reckon with. Some of the few firms who would "dare not introduce scientific methods. These methods, where introduced, have been brought in with the greatest caution, and at the risk that foremen first and then the rank and file of workmen would throw down their tools. The men might be beaten, but few employers will face the risk of closing their works; they had rather potter on with things as they are. The British artisan is the most skilful workman in the world, and he knows it; an English or Scotch fitter can turn out work better than any other work in Europe, and his machines, therefore, outlast those of any other country." But he will not turn to new methods until it is too late. "An able engineer, the head of large works in the North of England, told me, not a year ago, that the only way in which he could introduce a new labour-saving appliance was to throw it down in the shop with an indifferent and sceptical air; after it had lain there for some weeks, some foreman would take a fancy to it and bring it forward as an adoption of his own." Lastly, comes a complaint (20 years old) that a manufacturer will not believe that the geometry of a university professor can help him in the setting out of toothed wheels. As he probably believed that geometry and Euclid were one and the same, the poor man is to be excused. Ignorance and unwillingness to admit it we shall have with us always. From the hospitable columns of the *Times* the conflict overflowed into the British Association. Sir Henry Roscoe's views are known, and those of the other eminent men of science that spoke on the subject at Liverpool. Prof. Fitzgerald, however, defended the ideal of the universities—with modifications.

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THE PRINCIPLES OF ALTERNATE-CURRENT WORKING.*

BY ALFRED HAY, B.Sc.(EDIN.), A.I.E.E.

(Continued from page 289.)

61. If the E.M.F. and current in a circuit obey the simple harmonic law, and the angle of lag (Art. 18) is known, then we can at once calculate the power. In order to show how this may be done we shall have to prove the following two auxiliary propositions:

I. *The mean value of the product of two simple harmonic functions which are in phase with each other is equal to half the product of their maxima values.*

Let the two functions be represented by $A_1 \sin pt$ and $A_2 \sin pt$ respectively. At any time t, their product is equal to $A_1 A_2 \sin^2 pt$ (Art. 8). Hence the mean value of this product will be equal to $A_1 A_2$, multiplied by the mean value of $\sin^2 pt$. But the latter quantity we have shown (Art. 57) to be equal to $\frac{1}{2}$. The mean value of the product considered is therefore $\frac{1}{2} A_1 A_2$, which establishes the proposition.

II. *The mean value of the product of two simple harmonic functions which are in quadrature with each other*† *is equal to nothing.*

Let A L C M E (Fig. 49) and R B S D T be two sine functions which are in quadrature, and let the dotted line represent the values of the product of the two functions. Between A and B, and C and D, this product is negative, since the functions are of opposite sign; between B and C, also D and E, the product is positive, since the two functions are of the same sign over these intervals. Consider two points, H and N, which are equidistant from B. From the symmetry of the sine function it follows that H O = N P, and I H = N G. Hence the product of the two sine functions at the point H has precisely the same *numerical* value as at the point K. The same holds for every pair of points equidistant from B. Hence it follows that the positive half-waves of the dotted curve are equal in every respect to the negative half-waves, and, therefore, the mean value of the product considered over any complete number of periods is nothing.

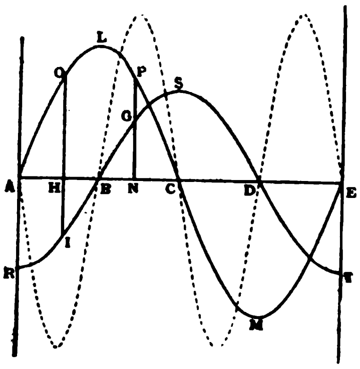

FIG. 49.

We may now apply the above results to the determination of the mean product of two sine functions with any phase difference between them whatever. Let the two functions be represented by the alternating vectors derived from the rotating vectors O A and O B (Fig. 50), the phase difference between which amounts to θ (Art. 18). Let the rotating vector O B be replaced by the two equivalent rotating vectors O C and O D (Art. 18), the first of which coincides in direction with O A, while the second is at right angles to it. This is equivalent to the splitting up of the simple sine wave L M N O P into two simple harmonic components (shown dotted in the figure), which are in quadrature with each other. If the sine function derived from the rotating vector O A be represented by O A sin pt (Art. 16), then that derived from O B will be represented by O B sin $(pt - \theta)$. But, referring to the figure, we see that

$$OB \sin (pt - \theta) = OC \sin pt + OD \sin \left(pt - \frac{\pi}{2}\right).$$

The problem is to find the mean value of

$$OA \sin pt \times OB \sin (pt - \theta),$$

i.e., of

$$OA \sin pt \left\{ OC \sin pt + OD \sin \left(pt - \frac{\pi}{2}\right) \right\},$$

or, $OA \sin pt \times OC \sin pt + OA \sin pt \times OD \sin \left(pt - \frac{\pi}{2}\right)$.

Applying proposition I. proved above, we find that the mean value of the first term is $\frac{1}{2}$ O A × O C. The mean value of the second term is, by proposition II., nothing. Hence the mean value of the product of the two functions is $\frac{1}{2}$ O A × O C. But O C = O B cos θ (Art. 12), so that the mean value of the product is $\frac{1}{2}$ O A × O B × cos θ. If, now, we suppose that the sine function derived from O A represents the E.M.F. in a circuit, and that derived from O B the current, then we have the following proposition:

If the E.M.F. and current in a circuit follow the simple harmonic law, then the power is equal to half the product of the maxima values of these quantities, multiplied by the cosine of the angle of lag.

62. The component of the current which is in quadrature with the E.M.F. is, as we have seen (Art. 61, Prop. II.), a current which does no work in the circuit; it transfers part of the energy developed by the source of alternating E.M.F. to the circuit, storing it up there in the form of a magnetic field. This storage of energy goes on so long as the component considered is increasing; when it reaches its maximum value, the storage ceases; and during the next

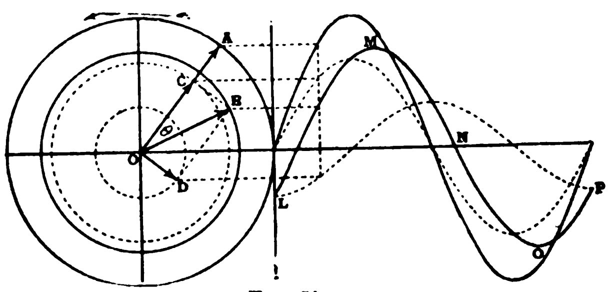

FIG. 50.

quarter-wave, when the component is decreasing, the energy is discharged from the circuit and returned to the source of alternating E.M.F. If in Fig. 49 the curve A L C M E represent the E.M.F. wave, and R B S D T that component of the current wave which is in quadrature with the E.M.F., then the dotted curve will be the power curve corresponding to that component, and the resultant power is nothing. For this reason, the component of the current which is in quadrature with the E.M.F. is sometimes termed the *idle* or *wattless* current.

The other component of the current, being in phase with the E.M.F., is always of the same sign as the E.M.F., hence the power due to this component is always positive. For this reason the component is sometimes referred to as the *load* current.

In Fig. 51 is shown the power curve corresponding to the E.M.F. and current curves of Fig. 50. This power curve may be analysed into two components: the one (shown dotted) corresponding to the *wattless* current, and consisting of equal positive and negative half-waves; the other (shown chain-dotted) corresponding to the *load* current, and containing positive half-waves only.

It is hardly necessary to draw the student's attention to the fact that a *wattless* current could not exist *by itself.* In order that this might be the case, it would be necessary to make the angle of lag $\frac{\pi}{2}$, a condition which would require the resistance of the circuit to be equal to nothing (Arts. 38 and 2).

63. If E and I denote the maxima values of the E.M.F. and current, which we suppose to obey the simple harmonic law, and if θ stand for the angle of lag, then, as we have

* Based on a series of evening lectures delivered at the University College, Liverpool.

† Two simple harmonic functions are said to be *in quadrature* with each other when the phase difference between them amounts to $\frac{\pi}{2}$ (one right angle).

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seen (Art. 61), the power is $\frac{1}{2}$ E I cos θ. This cosine of the angle of lag is a quantity which, under different guise, we have already had occasion to consider when dealing with the more general case in which the E.M.F. and current may vary according to any law (Art. 59). For $\frac{1}{2}$ E I $= \frac{E}{\sqrt{2}} \times \frac{I}{\sqrt{2}}$, and by the results established in Art. 57 $\frac{E}{\sqrt{2}}$ and $\frac{I}{\sqrt{2}}$ are the R.M.S. values of the E.M.F. and current respectively. Hence $\frac{1}{2}$ E I gives us the *apparent watts* in the circuit—*i.e.*, the product of the volts and amperes (Art. 59); and cos θ is the multiplier which converts the apparent into the true watts. We thus see that cos θ is simply the *power factor* (Art. 59) for the circuit considered.

64. The presence of inductance in a circuit has the effect of displacing the current relatively to the E.M.F., thus giving rise to an idle component of the current, and lowering the power factor. But, like many other things, inductance is not an unmitigated evil, and in some cases is made to serve very useful and important purposes. We shall work out a numerical example to show how in some cases considerable economy may be effected by pressing inductance into service.

Let a group of 10 incandescent lamps, each of which takes one ampere at 60 volts, be required to be run off alternate-current mains at 100 volts, with a periodicity of

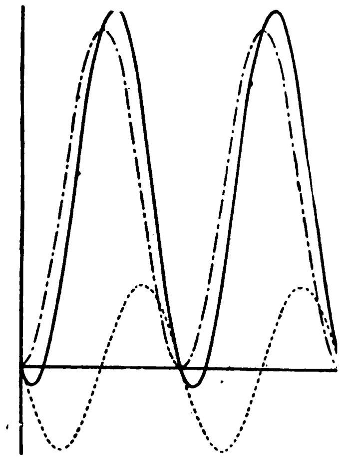

FIG. 51.

100 ⁀‿ per second, the E.M.F. following the simple sine law. The lamps being connected in parallel, their joint resistance will be six ohms. The problem, then, is to reduce the P.D. from 100 to 60. This might be done by using a simple resistance of four ohms. The objection, however, to this method (which is the only one available in the case of continuous currents) is that the resistance would absorb fully $4 \times 10^2 = 400$ watts, the lamps themselves requiring only $60 \times 10 = 600$ watts. Obviously, such a method would be very wasteful. There is, however, another method which is available with an alternating-current supply. This consists in using a *choking coil* to reduce the P.D. A *choking coil* is a coil (generally provided with an iron core) whose inductance is great compared with its resistance, and which is used in the same way in alternate-current working as a resistance is in the case of continuous currents. As an approximation, we shall suppose that the resistance of our choking coil is negligibly small, and that its inductance is L. The impedance of the coil will be equal (approximately) to the reactance p L (Art. 38). The resistance of the lamps being six ohms, the impedance of the whole circuit A B (Fig. 52) across the mains will be $\sqrt{6^2 + p^2 L^2}$. Now the current required is 10 amperes, and the P.D. is 100. Hence, we must have

$$10 = \frac{100}{\sqrt{36 + p^2 L^2}},$$

from which we find $pL = 8$, so that $L = \frac{8}{2\pi \times 100}$ $= \cdot 0127$ henry. A coil having this inductance will therefore reduce the P.D. so that the lamps will work at 60 volts.

65. The obvious advantage of a choking coil over a simple resistance lies in the fact that the former absorbs very little power; if we could entirely get rid of resistance* the coil would absorb absolutely no power. As it is, the small amount of power absorbed is easily determined by multiplying the square of the current by the resistance of the coil. In practice, choking coils are largely used with arc lamps for parallel working.

66. There is one point in connection with the problem we have just considered to which it may be well to draw the student's attention. If a non-inductive resistance is used to reduce the P.D., then the P.D. at the terminals of this resistance will be $4 \times 10 = 40$ volts, and the P.D. across the mains is the sum of the P.D.'s across the lamps and resistance respectively. But if a choking coil is used, then, calling x the unknown P.D. at the terminals of the choking coil, and remembering that

P.D. = current × impedance (Art. 38, equation 23),

we have

$$x = 10 \times L\,p = 10 \times 8 = 80 \text{ volts.}$$

The P.D. at the terminals of the choking coil is therefore not 40, as the student might at first sight have supposed, but 80. The sum, therefore, of the P.D.'s across the lamps and choking coil respectively does *not* give the P.D. across the mains. The reason for this, at first sight, somewhat puzzling fact lies in the phase difference between the two quantities. In the case where a simple resistance is used the two P.D.'s are both in phase with the current, but the P.D. of the choking coil is in quadrature with the current, so that in the second case the P.D. across the mains is represented by the hypotenuse of a right-angled triangle having its two sides equal to the P.D.'s across the choking coil and lamps respectively, as shown in Fig. 52.

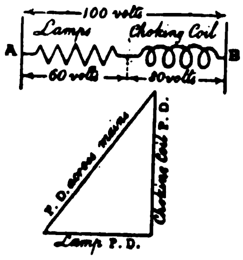

FIG. 52.

In this connection the student would do well to refer back to Arts. 37 and 38.

(*To be continued.*)

ELECTRIC GLOW LAMP TESTS.†

BY WILLIAM HENRY PREECE, C.B., F.R.S., ETC.

So much has been written on glow lamps, and so ably did Prof. Ayrton and Mr. Medley treat the subject in a paper read before the Physical Society on December 14, 1894, and on January 25, 1895, that it is now somewhat difficult to discuss any new question of commercial and scientific interest. However, as I have been investigating the quality of various glow lamps since the Edison-Swan patents collapsed, in order to establish a fair and reasonable specification for the Post Office requirements, and to find, if possible, an expeditious as well as reliable way of testing the efficiency and durability of lamps submitted in competition and delivery, I thought the results obtained would not be unwelcome to the members of the British Association.

My experiments were conducted on the following lines: (1) To find the efficiency and life of 100 and 105 volt 16-c.p. and 8-c.p. lamps in a trial of 2,000 hours' duration when kept alight continuously (night and day) at a constant voltage and the filaments at an approximately uniform temperature. (2) To ascertain the efficiency and life of lamps when similarly maintained at constant potential, but lighted for several consecutive hours daily, as in an ordinary installation. (3 and 4) Similar to (1) and (2), except that the duration of trial was limited to 1,000 hours. (5) To find the mean breaking voltage of filaments by gradually increasing the voltage for each lamp at about the same

* And *hysteresis* in the iron core, if one is used.

† Paper read before the British Association at Liverpool.

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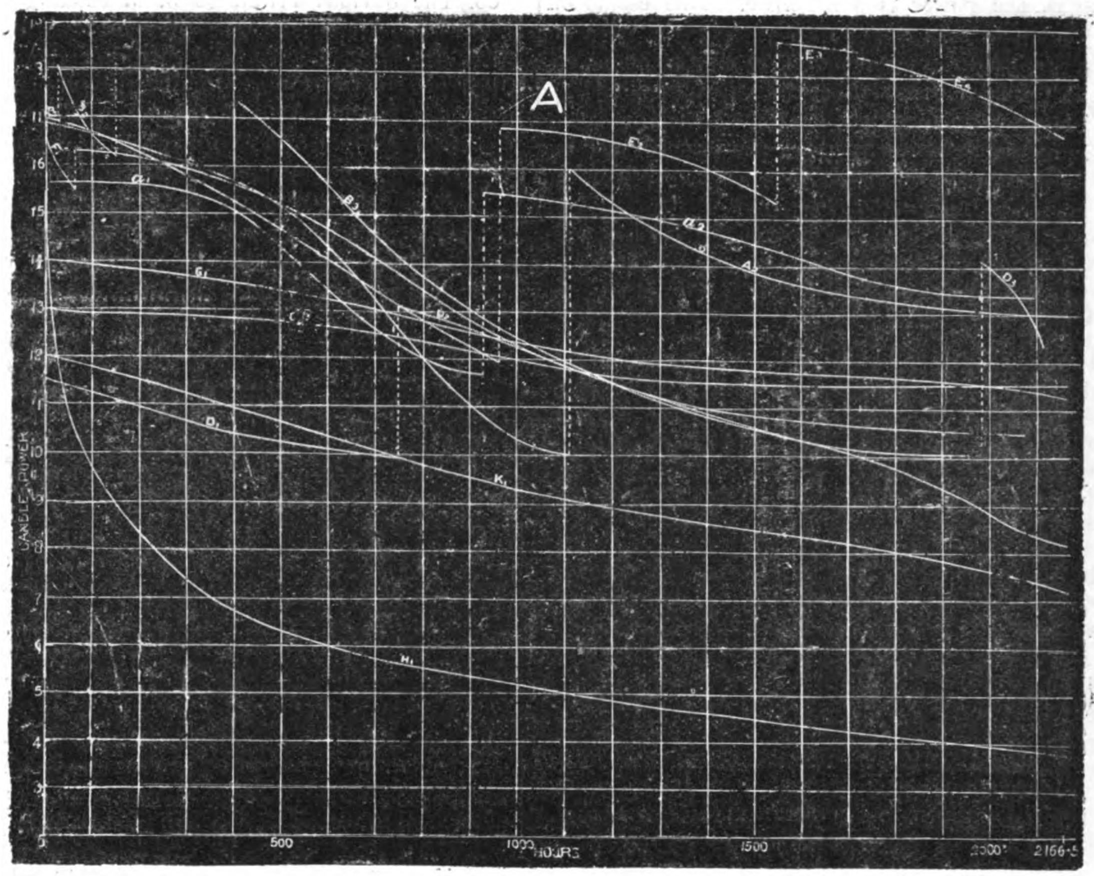
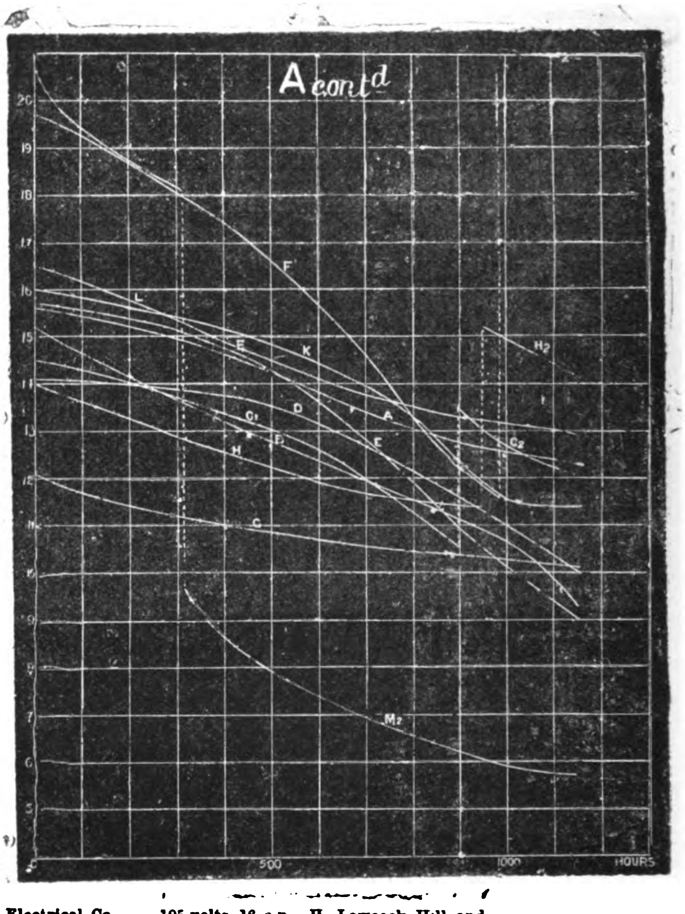


A, Edison-Swan .. .. 105 volts, 16 c.p.	E, Stearn .. .. 105 volts, 16 c.p.
a, „ .. .. 100 „ 16 „	F, International Electric Co. .. 105 „ 16 „
B, Siemens Bros. .. .. .. 105 „ 16 „	G, Bishop's Cluster Co. .. .. 105 „ 16 „
C, Brush Company .. .. 100 „ 16 „	H, Electrical Co. .. .. 105 „ 16 „
D, Laing, Wharton, and Down .. 105 „ 16 „	K, Sunbeam Lamp Co. .. .. 105 „ 16 „

A.—Curves of Candle-Power and Life.

Experiment.	Lamps. Volts.	c.p.	Supplied by
1 and 2	105	16	Edison-Swan Company.
	100	16	
	105	16	Siemens Bros.
	100	8	
	100	16	Brush Company.
	100	8	
	105	16	Laing, Wharton, and Down.
	100	8	
	105	16	Stearn.
	100	10	
	105	16	International Electric Company.
	100	8	
	105	16	Bishop's Cluster Company.
	100	8	
	105	16	Electrical Company, Limited.
	105	8	
	105	16	Sunbeam Lamp Company.
	100	8	
3 and 4	100	16	Electrical Company, Limited.
	105	8	
	105	16	Barclay and Son.
	105	16	Sturm and Co.
	105	8	
	105	16	P. Walters and Co.
	105	8	
	105	16	Conze and Simon.
	105	8	
	105	16	General Electric Co. (Robertson).
	100	8	
	105	16	Lowcock, Hill, and Co.
	105	8	
	105	16	J. Shaw (Gem).
	105	16	Rose and Bird.
	105	8	
	105	16	Mackey, Mackey, and Co.
5 and 6	105	16	Edison and Swan Company.
	105	16	General Electric Co. (Robertson).
	105	16	G. Straus.
	105	16	Sturm and Co.
	105	16	Conze and Simon.
	105	16	Lowcock, Hill, and Co.
	105	16	P. Walters and Co.
	111 to 119	11 to 16	As now supplied by the Crystal Electric Lamp Company.



A, Electrical Co. .. 105 volts, 16 c.p.	H, Lowcock, Hill, and Co. .. .. 105 volts, 16 c.p.
B, Barclay and Son .. 105 „ 16 „	K, James Shaw .. 105 „ 16 „
C, Sturm and Co. .. 105 „ 16 „	L, Rose and Bird .. 105 „ 16 „
D, P. Walters and Co. 105 „ 16 „	M, Mackey, Mackey, and Co. .. 105 „ 16 „
E, Conze and Simon 105 „ 16 „	
F, General Electric Co. 105 „ 16 „	
G, G. Straus .. .. 105 „ 16 „	

A.—Curves of Candle-Power and Life.

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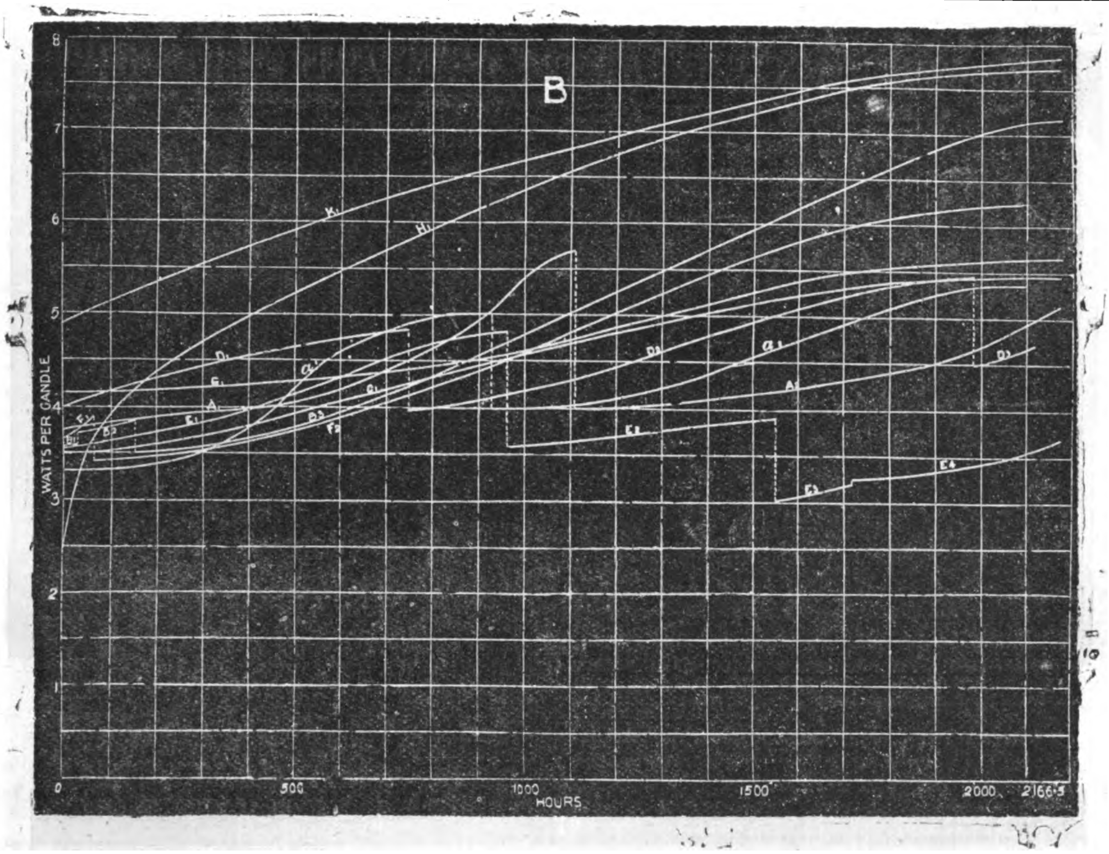


B.—Efficiency Curves, Corresponding to Curves A.

rate. (6) To see what the effect would be on similar filaments after being raised to three-fourths of their mean breaking voltage, as found by (5).

As several distinct series of experiments have been made by me since the end of 1894 it would perhaps be advisable to deal with each group separately. Between the months of February, 1894, and April, 1895, the lamps named in the preceding table were tried.

The whole of the following tests were carried out with a continuous current. All the electrical measurements of voltage and current were made with a Hartmann and Braun voltmeter, in conjunction with an Ayrton and Perry twisted strip amperemeter, and each instrument was frequently verified against a standard d'Arsonval galvanometer. A few secondary cells were used to regulate the dynamo potential on the 105-volt circuit,

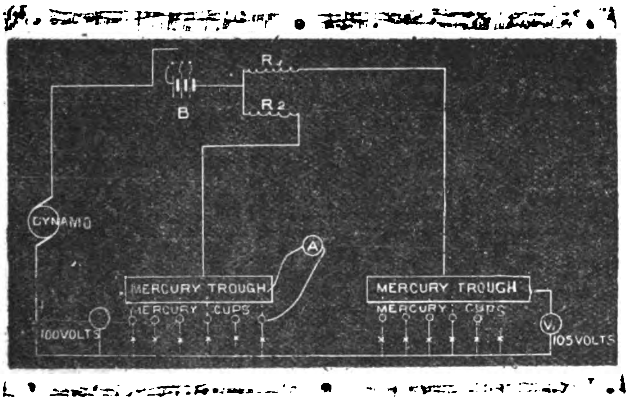
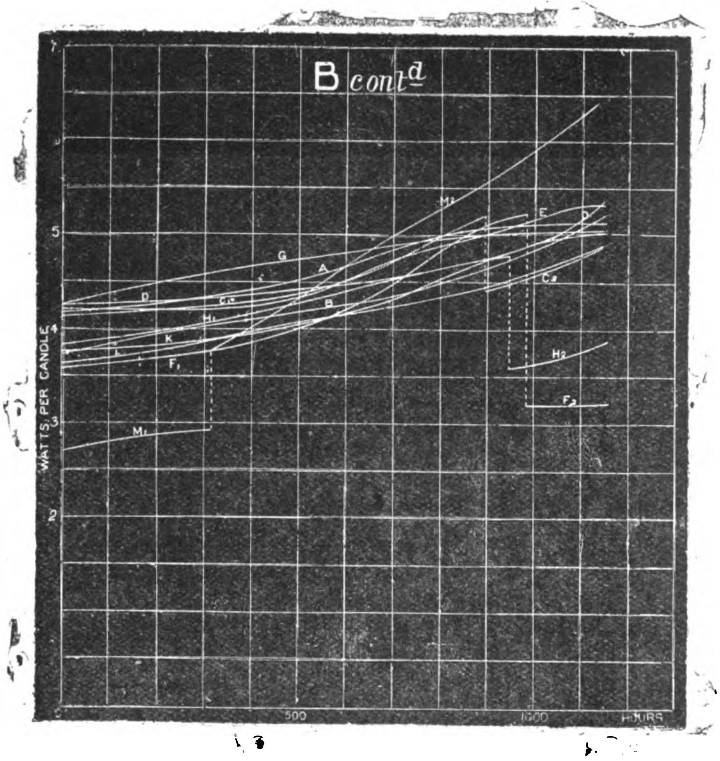


Fig. 1.

and adjustable resistances were employed to maintain the required potential at the ends of the respective lamps (Fig. 1).

For the continuous lighting experiments each lamp was fitted in a proper lampholder, attached to which was a short length of flexible twin conductor, and until the lamps were wanted for measurement they hung on hooks outside the photometer in positions marked to correspond with the lamps. To ascertain the candle-power of any one of the lamps, it was passed through a small door into the photometer space, and suspended from a clip on a carriage which could be moved over a graduated photometer bar. The illuminating power of the lamp was balanced against Messrs. Sugg and Co.'s standard candles on Rumford's shadow principle, and to ensure the greatest possible accuracy the mean value of the following three observations were recorded as the result: (1) through green glass; (2) through red glass; and (3) without any vitreous medium while the two lights were carefully shaded from the observer's eyes.



B.—Efficiency Curves, Corresponding to Curves A.

Two lamps out of 24 of each make were selected at random—one 16 c.p. and one 8 c.p., of 105 and 100 volts. The potential marked on the lamps was kept constant, and the current and candle-power were carefully measured once in every 24 hours. If a lamp collapsed within the prearranged 2,000 hours' trial, its life was noted, and another lamp substituted without delay. From the results obtained the following curves, A, B, C, and D, of "candle-power and life" and "watts per candle and life" have been prepared for 16-c.p. and 8-c.p. lamps comprised in Groups A and B. In addition to the above curves the summaries for Groups A and B show, at the end of 1,000 hours candle-power and efficiency, percentage drop in candle-power, and the "comparative efficiency" calculated on the assumption that an Edison-Swan 105-volt nominal 16-c.p. lamp, taking 3·75 watts per candle, is 100 per cent. efficiency. From the corresponding curves the behaviour of any one lamp at intervals of 100 hours can easily be obtained if required.

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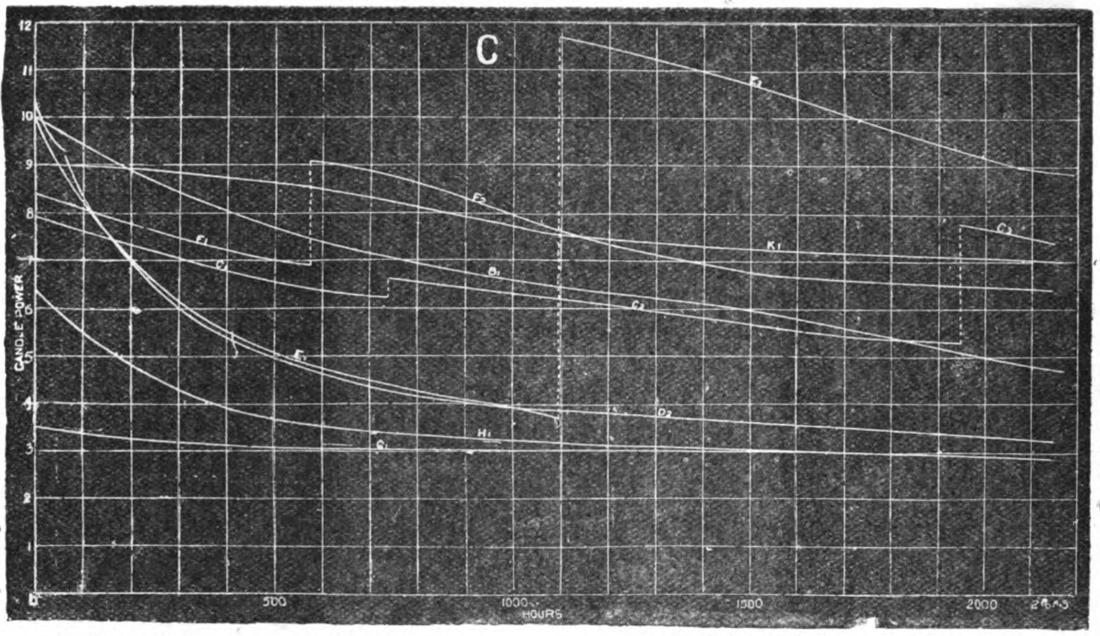
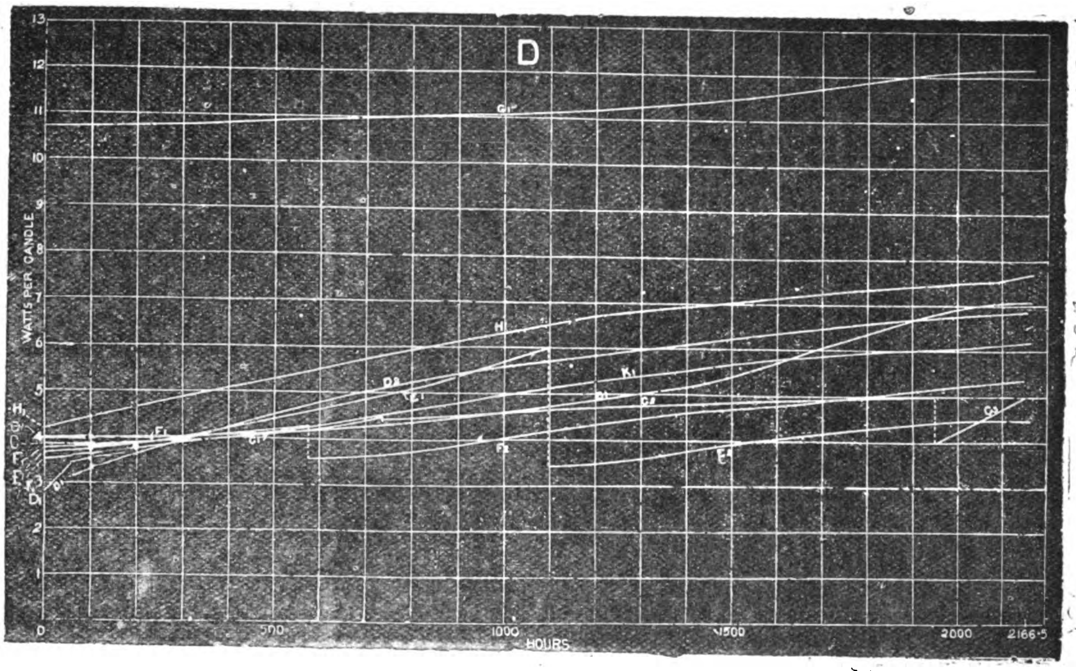
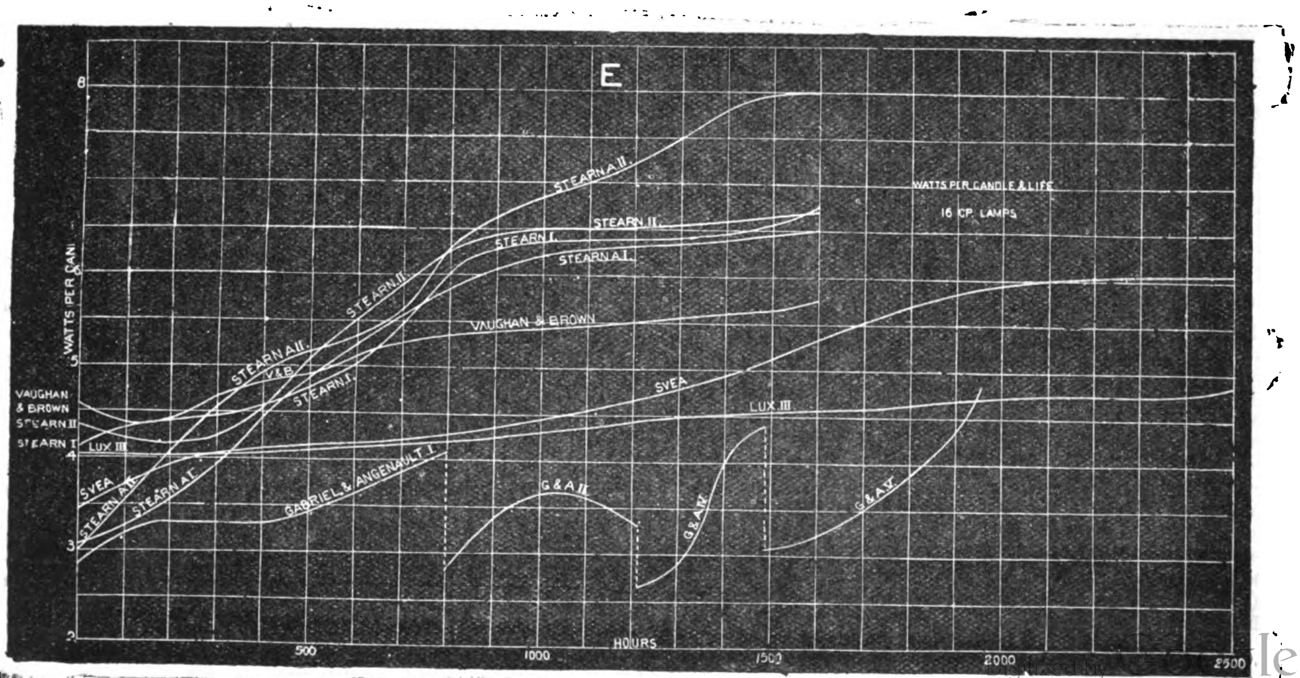


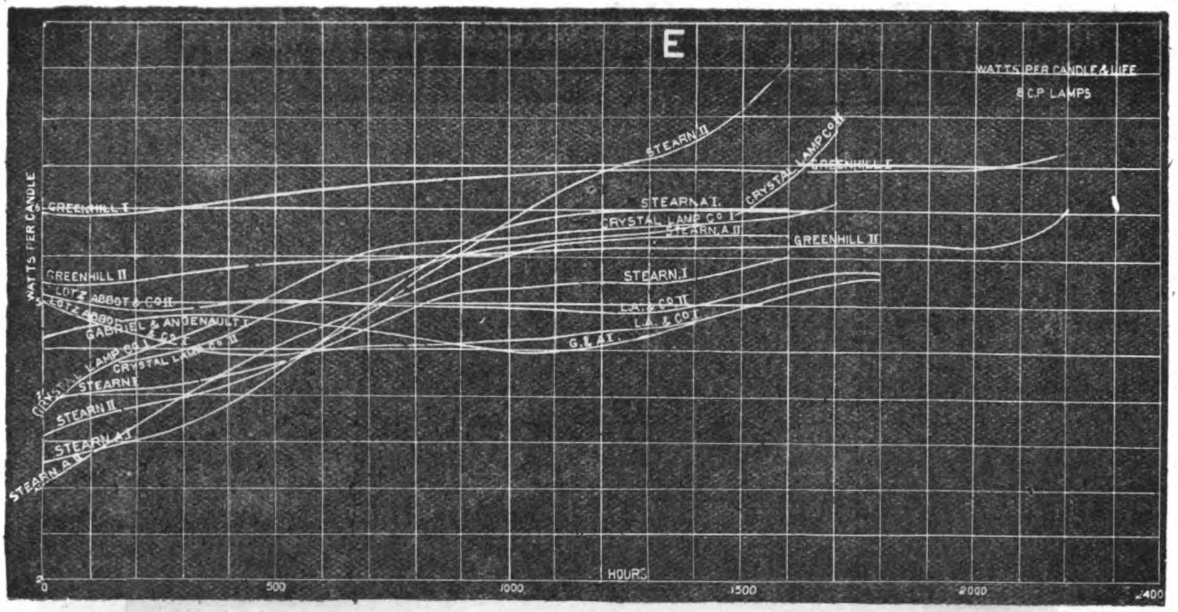
B, Siemens Bros...	100 volts, 8 c.p.	F, International Electric Co...	100 volts, 8 c.p.
C, Brush Co.	100 ,, 8 ,,	G, Bishop's Cluster Co... ..	100 ,, 8 ,,
D, Laing, Wharton, and Down	100 ,, 8 ,,	H, Electrical Co...	105 ,, 8 ,,
E, Stearn	100 ,, 10 ,,	K, Sunbeam Lamp Co.	100 ,, 8 ,,

C.—Curves of Candle-Power.



D.—Efficiency Curves, Corresponding to Curves C.





E 2.

GROUP A.

Summarised Behaviour of Nominal 16-c.p. Lamps in 1,000 Hours.

Note.—The numbers I., II., etc., indicate number of lamp in trial.

Firm.	Initial C.P.	Percentage drop in 1,000 hours.	Percentage efficiency. Of constancy in C.P.	Percentage efficiency. Comparative electrical.	Mean of columns 4 and 5.	Remarks.
Edison-Swan. 100 v. (II.)...	15·5	13·1	86·9	71·6	79·25	—
International Electric Co. 105 v. (II.) ...	16·3	26·6	73·4	79·8	76·60	—
Stearn. 105 v. (I.)	16·9	31·3	68·7	77·0	72·85	Only run 962 hours.
Siemens Bros. 105 v. (III.)...	18·35	35·9	64·1	73·0	68·55	—
Edison-Swan. 105 v. (I.) ...	16·9	39·0	61·0	69·5	65·25	First 105-volt lamp tested. The second 105-volt behaved more like the 100-volt lamp referred to above.
Electrical Co. 105 v. (I.) ...	15·0	65·3	34·7	59·1	46·9	—

The following four lamps started considerably below the stated 16 c.p., and are therefore regarded as of no comparative value :

Bishop's Cluster Co. 105. (I.)	14·0	11·9	—	—	—	—
Laing, Wharton, and Down. 105. (II.)	13·1	22·5	—	—	—	—
Brush Co. 100. (I.)	13·0	7·8	—	—	—	—
Sunbeam Lamp Co. 105. (I.)	12·0	22·6	—	—	—	—

The curves A, B, C, and D seem to indicate four classes of lamps: (1) those that start at about their nominal candle-power at a high efficiency, but very quickly show a decided falling off in candle-power and efficiency, and become practically useless in 400 or 500 hours ; (2) those that start off at about their nominal candle-power, give a useful light for about 1,000 hours, and then burn out ; (3) those that start off like (2), but do not break ; and (4) those that start off with a candle-power below their nominal value, and keep it up fairly steadily for 2,000 hours, or more.

With Class 1 lamps, frequent renewals will evidently be necessary to keep up a satisfactory light on any installation of considerable magnitude, but, as will appear later on, it would seem that my old prediction of a "short life and a merry one" is not to be disregarded. Classes 2 and 3 are apparently the most promising lamps for practical use, while those in Class 4 scarcely admit of fair comparison with the others in that they never reach their nominal candle-power. Throughout the prolonged tests of "continuous lighting," it will be seen from the data supplied that the candle-power of each lamp gradually dropped from the start to finish and the watts per candle rose.

GROUP A.

Summarised Behaviour of Nominal 8-c.p. Lamps in 1,000 Hours.

Note.—Numbers I., II., etc., indicate number of lamp in trial.

Firm.	Initial C.P.	Percentage drop in 1,000 hours.	Percentage efficiency. Of constancy in C.P.	Percentage efficiency. Comparative electrical.	Mean of columns 4 and 5.	Remarks.
Sunbeam Lamp Co. 100 v. (I.)	9·0	14·4	85·6	75·3	80·45	—
International Electrical Co. 100 v. (II.)...	9·08	25·9	74·1	78·6	76·35	—
Siemens Bros. 100 v. (II.)...	10 0	34·0	66·0	81·5	73·5	—
Laing, Wharton, and Down. 100 v. (II.).........	9·2	57·6	42·4	66·0	54·2	—
Stearn. 100 v. (I.)	10·3	61 9	38·1	65.8	51·95	Nominal 10 c.p.

The following three lamps started considerably below the stated 8 c.p., and are therefore regarded as of no comparative value:

Brush Co. 100 v. (II.)	6·6	5·42	—	—	—	—
Electrical Co. 105 v. (I.) ...	6·4	49·4	—	—	—	—
Bishop's Cluster Co. 100 v. (I.)	3·5	13·7	—	—	—	—

GROUP B.

Summarised Behaviour of Nominal 16-c.p Lamps in 1,000 Hours.

Firm.	Initial C.P.	Percentage drop in 1,000 hours.	Percentage efficiency. Of constancy in C.P.	Percentage efficiency. Comparative electrical.	Mean of columns 4 and 5.	Remarks.
Rose and Bird. 105 v. 16......	16·5	20·0	80·0	81·2	80·6	—
James Shaw 105 v. 16......	16·0	22·5	77·5	78·5	77·0	—
Electrical Co. 105 v. 16......	15·6	19·9	80·1	73·5	76·8	—
Barclay and Son 105 v. 16......	15 2	30·3	69·7	77·3	73·5	—
Conze and Simon 105 v. 16......	15·7	35·7	64·3	72·8	68·5	—
General Electric Co. 105 v. 16.	19·7	41·1	58 9	71·7	65·3	Only lasted 982 hours.

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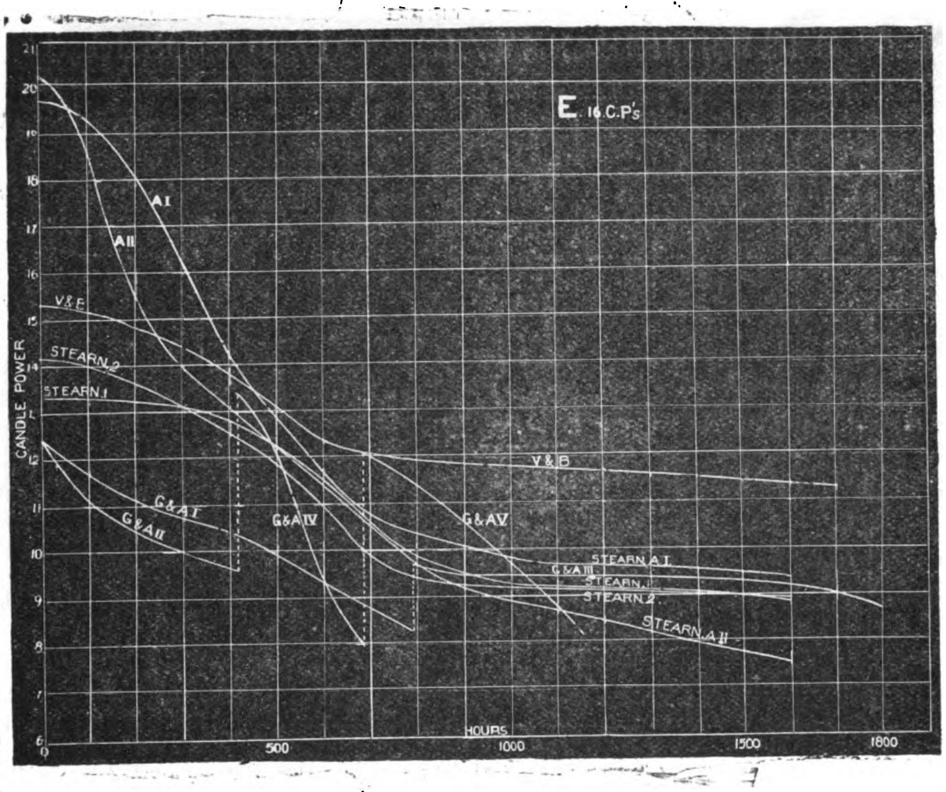
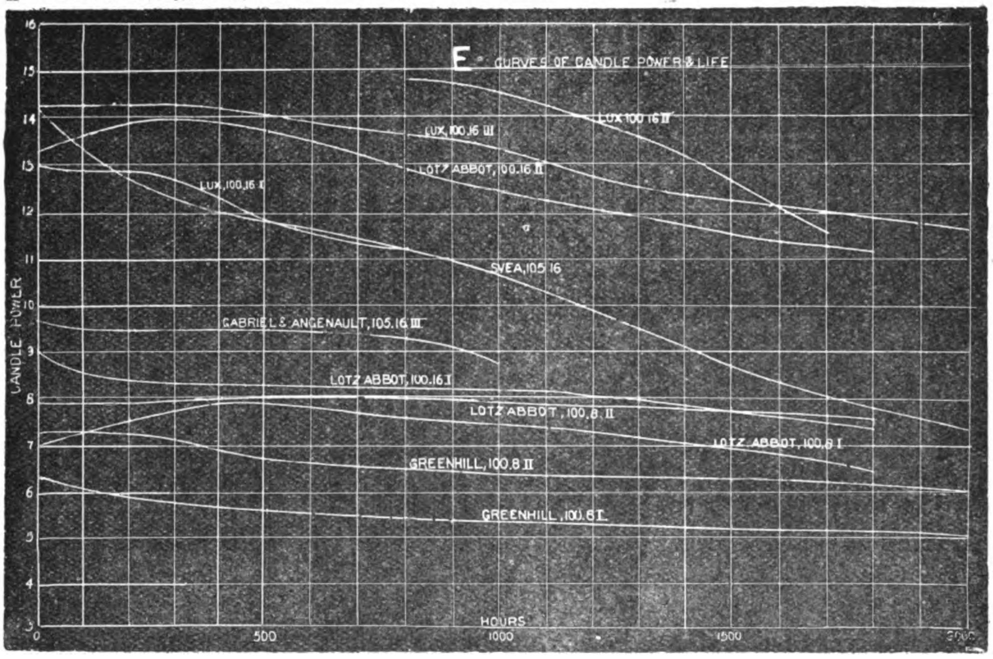


Vaughan and Brown, 105 volts, 16 c.p. Stearn A I., 105 volts, 16 c.p. Stearn A II., 105 volts, 16 c.p.
Stearn 1, 105 volts, 16 c.p. Stearn 2, 105 volts, 16 c.p. Gabriel and Angenault I., II., III., IV., and V., 105 volts, 16 c.p.

E 3.—Curves of Candle-Power and Life.



E 4.

The following four lamps started considerably below the stated 16 c.p., and are therefore regarded as of no comparative value.

Stürm and Co. 105 v. 16......	14·5	26·9	—	—	—	Only lasted 895 hours.
P. Walters and Co. 105 v. 16.	14·1	21·9	—	—	—	—
Lowcock, Hill, & Co. 105 v. 16.	14·0	18·6	—	—	—	Only lasted 945 hours.
G. Straus 105 v. 16......	12·1	14·9	—	—	—	—

The next experiments were conducted between April, 1895, and February, 1896, and the results are shown in Group E—"Summary and Corresponding Curves." In this group (E) I met with several lamps which supported Prof. Ayrton's investigations—that is, the candle-power increased at first, and then

Group E.

Summarised Behaviour of Nominal 16-c.p. Lamps in 1,000 Hours.

Firm.	Initial C.P.	Percentage drop in 1,000 hours.	Percentage efficiency. Of constancy in C.P.	Percentage efficiency. Comparative electrical.	Mean value of 4 and 5.	Remarks.
Stearn. (A. 1.) 105 volts. 16 c.p.	19·7	50·25	49·75	60·4	55·07	—
Stearn. (A. 2.) 105 volt. 16 c.p.	20·2	55·69	44·31	55·2	49·75	—
Vaughan and Brown. 105 volts. 16 c.p.	15·3	22·9	77·1	69·0	73·1	—

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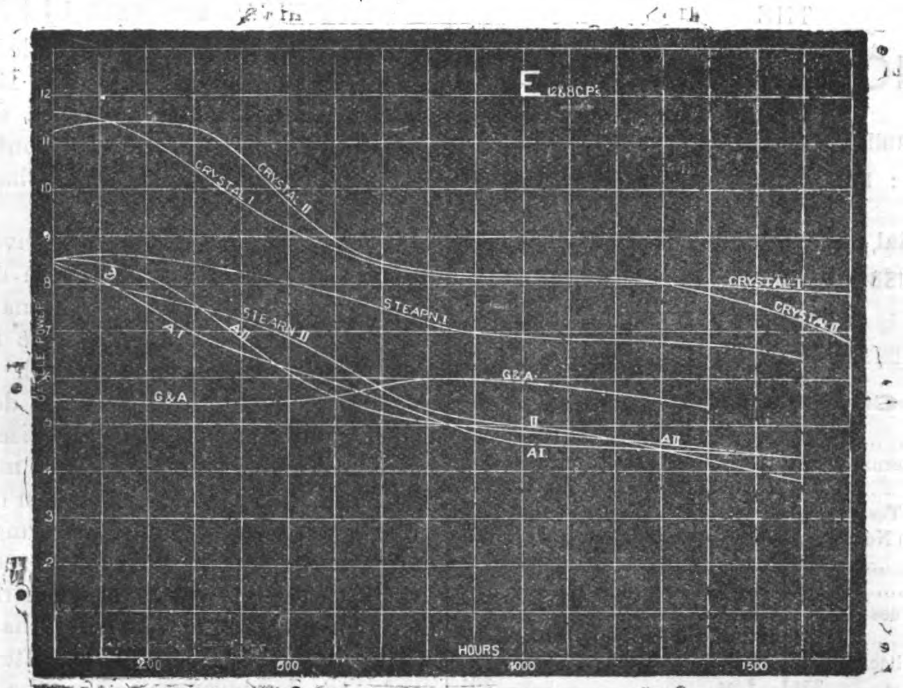

Crystal Company, 57 volts, 12 c.p., No. I. Stearn, 105 volts, 8 c.p., A I. Stearn, 105 volts, 8 c.p., I.
" " 57 " 12 " No. II. " 105 " 8 " A II. " 105 " 8 " II.
Gabriel and Angenault, 100 volts, 8 c.p.
E 5.—CURVES OF CANDLE-POWER AND LIFE.

The following five lamps started considerably below the stated 16 c.p., and are therefore regarded as of no comparative value:

Gabriel and Angenault. 105 volts. 16 c.p. (1)	12·4	32·99 793 hrs.	67·01	92·6	79·82	Lamp burned 793 hours.
Gabriel and Angenault. 105 volts. 16 c.p. (III.)	9·7	10·3	89·7	91·5	90·6	—
Stearn. (1.) 105 volt. 16 c.p...	13·3	30·1	69·9	58·3	64·1	—
Stearn. (2.) 105 volts. 16 c.p...	14·1	34·1	65·9	57·6	61·7	—
Lux. 100 volts. 16 c.p.	12	5·75 757 hrs.	94·25	66·1	80·18	Lamp filament broken after 757 hrs.

GROUP E.

Summarised Behaviour of Nominal 8-c.p. and 12-c.p. Lamps in 1,000 Hours.

Firm.	Initial C.P.	Percentage drop in 1,000 hours.	Percentage efficiency. Of constancy in C.P.	Comparative electrical.	Mean value of 4 and 5.	Remarks.
Stearn. (A. 1.) 105 volts. 8 c.p.	8·25	46·0	54·0	63·2	58 6	—
Stearn (A. 2.) 105 volts. 8 c.p.	8·43	43·4	56·6	68·1	62·3	—
Stearn. (No. 1.) 105 volts. 8 c.p.	8·5	18·8	81·2	72·5	76·8	—
Stearn. (No. 2.) 105 volts. 8 c.p.	8·4	40 7	59·3	63·8	61·5	—
(No. 1.) Lamps as now made by the Crystal Electric Lamp Company 57 v. 12 c.p.	11·6	30·17	69·83	65·8	67 8	—
(No. 2.) " " 57 v. 12 c.p.	11·27	26·7	73·3	67·0	70·01	—

The lamp below started considerably below the stated 8 c.p., and is therefore regarded as of no comparative value:

Gabriel and Angenault. 100 volts. 8 c.p. ...	5 52	*6·4	106·4	75·3	90·8	—

diminished. A so-called 100-volt 8-c.p. Gabriel and Augenault lamp began at $5\frac{1}{2}$ candles, and remained practically constant

Summarised Behaviour of Lamps marked 16 c.p. and 8 c.p. in 1,000 Hours. It will be seen below that only one lamp (Lotz-Abbott, 100 volts, 8 c.p., No. II.) out of the eight tested gave the right candle-power at the start.

Firm.	Initial C.P.	Percentage drop in 1,000 hours.	Percentage efficiency. Of constancy in C.P.	Comparative electrical.	Mean value of 4 and 5.	Remarks.
Lux. 100 v. 16 c.p. (II.)	14·3	7·0	93·0	87·5	90·25	—
Svea. 105 v. 16 c.p.	14·3	25·87	74·13	84·1	79·11	—
Lotz-Abbott. 100 v. 16 c.p. (I.)	9·1	10·4	89 6	52·7	71·1	—
Lotz-Abbott. 100 v. 16 c.p. (II.)	13·3	5·26	94·74	78·8	86·72	—
Lotz-Abbott. 100 v. 8 c.p. (I.)	7·0	*5·71	105·71	81·6	93·6	—
Lotz-Abbott. 100 v. 8 c.p. (II.)	7·9	0	100	75 9	87·95	—
Greenhill. 100 v. 8 c.p. (II.)......	7·3	12·3	87·7	64·9	76·3	—

The lamp below started considerably below the stated 8 c.p., and is therefore regarded as of no comparative value:

Greenhill. 100 v. 8 c.p. (I.)......	6·4	16·4	83·6	59·0	71·3	—

during the first 400 hours. It then gradually rose 10 per cent. (6·18 candles) to the 800th hour, after which the light slowly diminished to the starting luminosity, but the watts per candle were then higher than at the beginning of the trial. Lotz-Abbott lamp, 100 volts, 16 c.p. (No. 2), rose from 13·3 to 14 candles in 400 hours, and then fell continuously. Lotz-Abbott lamp, 100 volts, 8 c.p., began at 7 and increased to 7·9 candles in 500 hours, and then dropped gradually. In 1,400 hours the candle-power was the same as at the commencement of the test. The watts per candle varied from 5 at the start to 4·71 at the 1,400-hour point. Two other lamps, as made by Stearn and the Crystal Electric Lamp Company, slightly increased in candle-power up to 200 hours, and then slowly diminished.

(To be continued.)

Mexican Patents.—The Mexican Congress has passed a new patent law which will enable patents which have been accidentally forfeited, owing to failure to comply with the stringent conditions of the existing law, to be revived, providing payment of the fees is made and various forms complied with within three months of the promulgation of the new law.

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ELECTRICAL BUSINESS IN NORTH SPAIN.

Some little time ago we called attention to a consular report by our consul at Bilbao wherein it was stated that, though a good deal of electrical work had been done and was contemplated in the North of Spain, very little of that work came to English firms.

We have somewhat carefully investigated matters of trade in the North of Spain during a visit to that region. Confining our remarks here almost entirely to electrical business, we may at once say that it is questionable if English firms realise the amount of work that has been done or is under consideration. If they had realised the fact, their travellers and agents would be more in evidence. We found little or no indication of English enterprise, but much of French, German, and Belgian, and even American. At the present time, however, America and all things American are tabooed. Our investigations showed that, as is usual with many English firms, attempts had been made to do business after the fashions which hold here, with no consideration for the methods which govern Spanish action. "You English people are accustomed to say 'yes' or 'no' if you want or do not want a thing. The Spaniard procrastinates, and up to a point maintains he does not want a thing when he wants it all the time. 'No' with him does not always mean 'no,' but means that the old bartering and chaffering spirit is too strong, and that he hopes by this means to run down the price at which the goods are offered." Then, again, in order to obtain business, competitors have undersold us, not, indeed, with goods of equal quality, but with such goods as we could easily supply if it were not that we have a little conscience left, and having asked a price for goods that will really pass muster we do not change our price for other goods of an inferior quality. Insulated wire, for example, can be sold at varying prices; but though all the wire may be sold as insulated wire, that does not guarantee its insulation. Fittings, again, are fittings; they may be cheap and when new catch the eye, but that does not prove them to be serviceable and lasting. The cheap and nasty have caused many troubles in Spain, and among the more far-sighted there seems an inclination to pay some attention in the future to quality as well as to price. A fact not always thought of in ordinary discussion is that "town" may mean quite a different thing to one person than to another. Towns in England are large and populous—in Spain many towns are not so large as our villages, and have the houses scattered over considerable areas. Many of these small towns are already lighted electrically. Travelling through the Pyrenees one is surprised to see the station, the streets, and some of the straggling houses fitted up with the incandescent lamp. The surprise ceases when it becomes known that water power is available, coal almost unknown, and oil the only possible illuminant to compete against electricity. At many of these places electricity was eagerly welcomed, and for such small places is heartily supported.

It was our good fortune to meet with the

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principals of a firm commencing to take a somewhat active part in matters electrical. This firm is in negotiation with three towns about to introduce electricity. They pointed out that not only was it necessary to get firms of repute to carry out the work, but they must be prepared to send men of experience to supervise the carrying out of the work. In several cases plants have been brought and sold, and badly installed. The latter has caused a good deal of dissatisfaction, and good machinery has brought its maker into disrepute because of this. Once more we must repeat that, so far as we could gather, the day of excessive cheapness is past. No English town would permit for a moment such buildings as constitutes the central station at San Sebastian. No English company or municipality would think of erecting them except as a temporary makeshift. Bilbao is but little better, and, in fact, most of the structures we saw labelled central stations were more of the character of old-fashioned barns than for the protection, preservation, and due maintenance of valuable machinery. We trust, at any rate, that some of our English firms will make enquiries as to the possibilities of work in Spain, and that business may be obtained from such enquiries. In writing upon this subject previously we referred to the question of money. We were assured that money was not wanting, that it would be forthcoming, but that business must be transacted keeping in view Spanish as well as English methods.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

WORKHOUSE LIGHTING BY ELECTRICITY.

SIR,—Would you oblige by inviting, through your columns, anyone who could give information as to any workhouse or other similar establishment which has been or is about to be lighted by electricity to communicate with me. My Board is considering the subject, and would much esteem any particulars furnished to them which might be of assistance.—Yours, etc.,

CHAS. TAYLOR, Clerk to the Guardians.

Isle of Thanet Union, Minster, Ramsgate,
Sept. 18, 1896.

CABLES.

SIR,—We have read with interest the letter from Mr. Callender referring to our high-conductivity lock-armoured electric cables. We see that he gives you notice that this is an infringement of certain patents issued to Messrs. Latch and Batchelor as far back as 1884. We may say that these patents refer to matters with which we are not concerned, and they do not affect the novelty of our new electric cable. If Messrs. Callender and Co. consider that they can prevent our manufacturing and selling our armouring, we shall be willing to meet them at the proper time in the Law Courts, where the question can be settled by proper authorities. Meanwhile, we shall continue to advertise, vend, sell, and use our new electric cables, and we desire through your columns to inform our friends that we are perfectly prepared to protect them against any action that Messrs. Callender and Co. or others may think proper to take.

We would also like to thank Mr. Callender for his letter to you, for we very much appreciate his kindness in calling the attention of the trade to our manufactures.—Yours, etc.,

W. T. GLOVER AND CO.

Westminster, S.W., Sept. 21, 1896.

ELECTRICAL DISTURBANCES IN SUBMARINE CABLES.*

BY W. H. PREECE, C.B., F.R.S.

Many interesting problems arise from time to time in the practical applications of electricity which tend to develop, or confirm, theoretical deductions on a scale beyond the dreams of the laboratory experimenter. In no branch has this been more pronounced than in submarine telegraphy. Long-ocean cables contain invariably only a single core.† Multiple cables—that is, cables possessing more than one core—are usually short in length, and are, in consequence, free from those disturbing elements which, existing in long lengths, make such circuits difficult to operate successfully. A *disturbance* is the result of the expenditure of energy in the wrong place. It tends to loss of efficiency. In telegraphy this means mutilation of signals and loss of speed in working. In telephony it means indistinctness of speech, the presence of extraneous and distressing sounds, or the reduction of distances through which speech is practical.

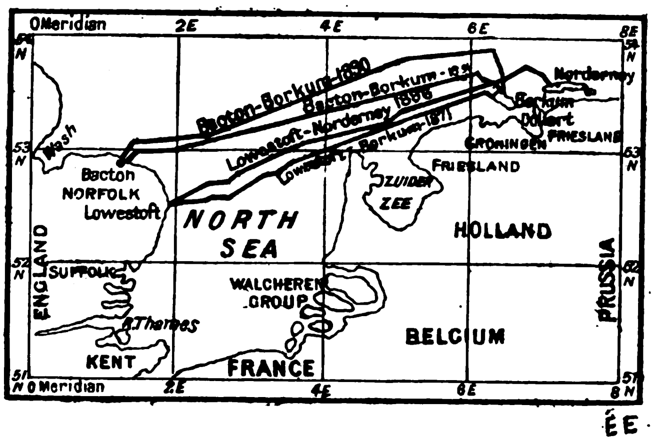

FIG. 1.—Map of Part of North Sea, showing Bacton-Borkum (2), Lowestoft-Norderney and Lowestoft-Borkum Cables.

The longest multiple cables worked by the British Post Office are those connecting the coast of Suffolk and Norfolk with Germany, and these cables have four cores each. The following table gives their lengths and particulars:

Name of cable.	Date laid.	Length in nautical miles.	Capacity in microfds K.	Resistance in ohms. R.	K R.‡	Remarks.
Lowestoft-Norderney	1866	225	73·1	2,710	198,100	No brass tape.
Lowestoft-Borkum	1871	225	66 0	2,666	175,950	Ditto.
Bacton-Borkum	1891	211	63·0	2,380	149,940	Ditto.
Bacton-Borkum	1896	224	84·0	1,510	126,000	Separate brass tape round each core.

The Norderney and other cables in the North Sea having been attacked and punctured by the *Limnoria terebrans*, a small boring mollusc, it was decided to cover the cores of all new cables with brass tape armour, an effective remedy against this depredator. Hitherto brass tape had been used solely for this particular purpose. It was wrapped round the whole of the cores after they were stranded together; but for other reasons which will appear, the second Bacton-Borkum cable, laid this year, had each core separately and independently so protected. These four cables, each with four cores, form 16 circuits, of which 14 are worked as a rule by the Hughes type-printer; but on two circuits the double-current Morse system is employed. In all cases the earth is used as the return. The

* Paper read before the British Association at Liverpool.

† The term *core* is applied to the copper conductor and its insulating sheath or dielectric.

‡ The product K R expresses the law that the time constant of a circuit varies as the product of its active capacity and its ohmic resistance.

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presence of disturbances from induction was first seriously brought under notice after the laying of the Bacton-Borkum cable in 1891. This cable is one of the ordinary four-core P.O. standard type, without any brass taping, a section of which is shown in Fig. 2. On commencing to work the four wires, it was found that, although we had a perfect cable, with better copper, and guttapercha of lower static capacity than usual, the Hughes working upon the four circuits was very unsatisfactory. Twelve months after its submersion, a series of observations was made upon the three then existing Ango-German cables, when it was made clear that there was still very much more disturbance upon the 1891 Borkum than upon the old cables *viâ* Lowestoft.

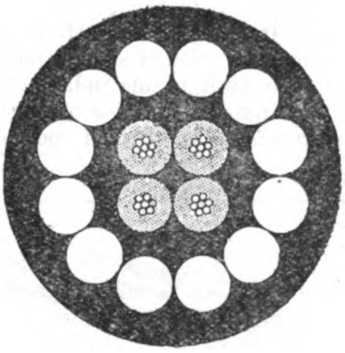

Fig. 2.—Ordinary Four-Core Submarine Cable. Deep-Sea Type. 107lb. Copper, 150lb. G.P. to Scale.

After very careful examination and consideration it was concluded that the difference was due to the better mechanical condition of the new cable, upon which the compound was still practically sound, preventing a complete and continuous soaking with water of the hemp yarn around and between the cores, with the consequent absence of the shielding effect which existed in the older cables, owing to their more thorough saturation. It was consequently assumed that the new cable would improve with age. But this disturbance presented itself in a more serious manner when attempts were made to work *duplex* Hughes, and also when testing the Wheatstone automatic system upon one of the cores. It was found that duplex Hughes was just possible, but owing to the disturbance from the other cores the signals were mutilated so frequently that working was too unreliable for ordinary business. The disturbances from Wheatstone working were still more serious. The Hughes apparatus is worked by short, sharp, intermittent currents, separated from each other by varying intervals of time. These time intervals determine the letter to be printed. The latter maintain the same direction throughout. The former vary with the *voltage* and the latter with the *amperage*.

During the experiments with the Wheatstone system, to which I have referred, it was found that the disturbances on the Hughes circuits, due to automatic sending on another core of the same cable, increased with the rate of working. Thus, with the same voltage—viz., 80—at key speed (30 words per minute), the effect was negligible; automatic (40 words per minute), the effect was distinct; automatic (50 words per minute), the effect was serious; maximum speed of the cable (70 words per minute), the effect was prohibitive. The greatest disturbances were observable when automatic and Hughes were working in opposite directions. The signals on the Hughes were sometimes in advance and sometimes in retard. Hence they were so greatly mutilated that Hughes working was impossible This was due to the *consonance* which occurs in two parallel circuits. When the mutual inductive influence, either electrostatic or electromagnetic, or both, between them, produces in either conductor greatly increased or greatly diminished currents, the one will advance and the other retard the signals so as to render telegraphy impracticable. The brass tape around each core entirely shields the conductors from electrostatic induction. The separate and independent brass taping of the 1896 cable has fully complied with my anticipations. The disturbances upon the cables are reduced to a negligible extent. They are one-sixth of those observed on the 1891 cable. They would entirely disappear if we could remove the electromagnetic effects. The possible rate of working, after several months' submersion, on the new cable is 33 per cent. greater than on the 1891 cable, but this is due chiefly to the reduction of the K R. The improvement in the signals is shown by the two recorded curves (Fig. 3).

The time constant* of the 1891 cable is 0·0513 second, and that of the 1896 0·0450 second, measured by the Hughes instrument, which is a capital chronograph.

Part II.—Telephone Cables.

An important form of multiple cable to consider is that required for telephone working. The cable connecting England and France, forming the Channel section of the London-Paris telephone circuit, has cores of the ordinary type as shown in Fig. 1, using guttapercha as the insulating medium, but with its capacity and resistance reduced to a minimum. It gives two circuits between London and Paris, and works very satisfactorily; but we want to bridge over greater distances, and eventually we hope to reproduce speech even across the Atlantic. The Dover-Calais type would not do for a greater distance than, say, 30 nautical miles. The distance to Belgium is 47 nautical miles, to Holland 108, to Germany 211 nautical miles. These cables had been all tested to see if speech was possible on them, commercially or experimentally. On the cable between Bacton and Borkum, which is 211 miles long, no telephonic signals could be distinguished. On the Holland cable, however, speech was experimentally possible but not practical with the present apparatus. With paper as the dielectric, having half the specific inductive capacity of guttapercha, and with our later experiences of air spaces, cannot we devise a new form of cable that will bridge over these greater distances? We must eliminate all disturbances, and we must reduce capacity and resistance to their lowest limits. The former is simple, for well-insulated, symmetrically-twisted metallic circuits are free from all external disturbances. The latter

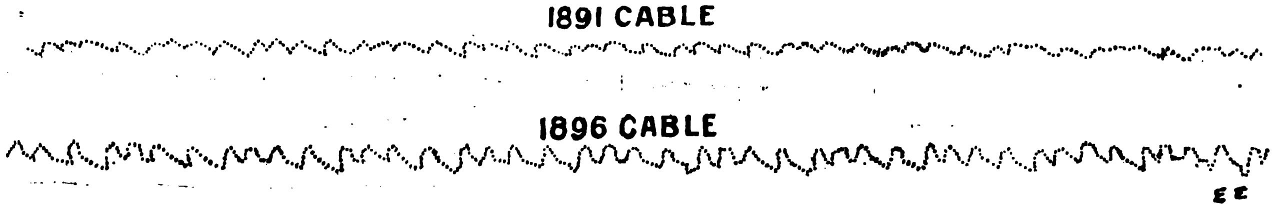

Fig. 3.

The causes of disturbance are induction and leakage. The latter may be ignored, for the insulation of our cables is practically perfect. The induction may be either *electrostatic* or *electromagnetic*. The former is the primary agent in reducing the speed of working in telegraphs, and in deteriorating the clearness of speech in telephones. A part of the energy of the current is absorbed by the capacity of the line, and stored up as a charge producing in discharge retardation and prolongation of signals. Electrostatic induction between core and core is the principal cause of the disturbance between the conductors of multiple cables. Electromagnetic induction also produces serious disturbances on straight parallel circuits with earth return, whether used for telegraphs or telephones, but between the two wires of a metallic circuit it may have a very beneficial influence in telephone working. It is very easy to differentiate the electrostatic from the electromagnetic effects. The former differ in direction at each end of the circuit when discharging.

* The *time constant* here referred to is the time that the current takes to rise to the necessary strength to work a relay in normal adjustment.

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is more complicated, and is surrounded with great practical difficulties. The problem is to diminish the time constant of a metallic circuit so that it shall approach zero. If there were no time constant, current waves would rise instantly to their working maximum and as rapidly fall to zero. If we could materially diminish the causes of retardation in such cables, speech by telephone would be possible to great distances. This can be done theoretically by neutralising the effect of static capacity by the opposite effect of electromagnetic induction.

The conditions which retard current waves and thus determine the time constants in single conductors embedded in a solid cylindrical dielectric are very different to those which act in double conductors or parallel metallic loops. Lord Kelvin in 1855 dealt with the cases of direct currents and distributed capacity in a complete single circuit. The surface of the conductor in such a cable is one plate and the earth the other plate of a condenser. At every point of the course of the current this capacity must be satisfied. Work is done on the dielectric in establishing an electric field. Lines of electric force are formed through the medium, varying in number with the force exciting them and with the thickness and specific inductive capacity of the dielectric. Energy is stored up. The charge thus held must be neutralised or dissipated. Discharge to earth through each end is the result, and this, with the resistance of the circuit, produces retardation of signals. Neutralisation has been attempted in submarine telegraphy by sending reversed currents, but with only partial success.

With parallel conductors and telephone working the conditions are very different. The total energy expended in any circuit in a given time may be considered under

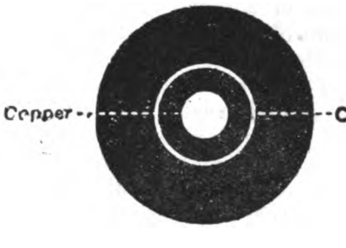

Fig. 4.

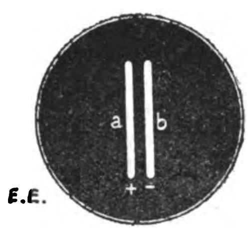

Fig. 5.

three heads: (1) that expended in overcoming resistance; (2) that expended in producing the electric field; (3) that expended in producing the magnetic field.

In each case we must consider the energy stored up and that dissipated. The former tends to retardation, the latter to work done, and therefore to reduction of efficiency. Careful regard must be paid to the directions in which the different disturbing forces act, for it may be that they oppose each other, and direct the energy into the original channel under modified and more favourable conditions. Thus, if the whole effect of the electrostatic field is neutralised by that of the electromagnetic one, the total energy developed is expended on the circuit itself, disturbances are eliminated and the service improved. This is the case of a metallic circuit having a microphone transmitter at one end and a telephone receiver at the other. The capacity of such a system will tend to store up a portion of the energy of each current, but the electromagnetic induction between them will tend to supply the deficiency. If the two wires of the loop be far apart, the influence of mutual induction will be much less than that of capacity. As they approach, the electromagnetic induction must increase at a greater rate than that of the electrostatic induction, until, finally, at the limit when they coincide, the one must exactly neutralise the other. This, perhaps, is better seen if we consider the case of a concentric cable; for, in this case, the number of lines of electric force does not increase, while the number of lines of magnetic force cutting the other conductors does increase rapidly as the outer conductor approaches the inner. The maximum induction from each source must take place when the two conductors are infinitely near each other, and this maximum must equal the primary current, for it cannot exceed it unless there were fresh creation of energy. Thus, as the separating dielectric becomes smaller and smaller the two effects approach each other closer and closer, until at absolute contact they annul each other. The result must be that if these be the only conditions present the time constant must diminish as the two conductors approach each other, and in the limit it must disappear. Twenty miles of concentric cable (Fig. 4), insulated with paper, were made and laid in the streets of London to test this reasoning, and comparisons were made with ordinary parallel cylindrical conductors, insulated both with gutta-percha and with paper and air. The result was very encouraging, but an unsuspected difficulty arose from the want of symmetry of the capacity of each conductor and the earth. The insulation resistance of each conductor was also different, and the result was that when the concentric cable was joined to overground wires, serious disturbances were experienced in the working circuits, which, however, were remedied by crossing the conductors of the concentric cable at several points, so that each side of the circuit was sometimes the inner and sometimes the outer conductor. This, however, is a cure that could not easily be applied to a submarine cable. It is clear that in such a cable symmetry of capacity with earth and of insulation is essential.

The experiment with the concentric cable shows that we have to consider not only the capacity between the two conductors, but that between each conductor and earth. Symmetry can be produced if the conductors be shaped and arranged as in Fig. 5. Only a certain number of lines

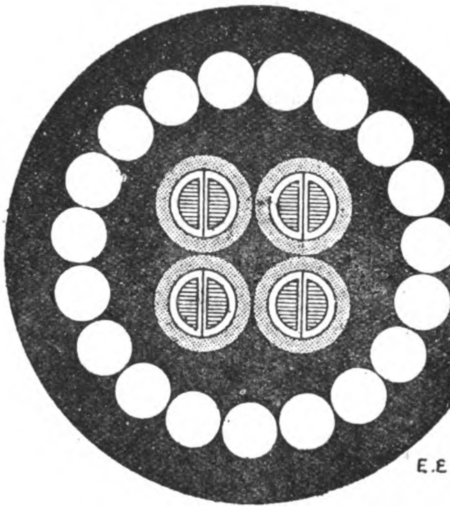

Fig. 6.

of electric force, dependent on the voltage present, can emanate from each conductor. The closer *a* and *b* (Fig. 5) are to each other, and the further they are from the earth, the greater the number of lines between the conductors and the fewer to the earth. The electric field is, in that case, confined almost entirely to the space between *a* and *b*. Taking the transverse action upon each element of such a core working telephones, each conductor is a source of periodic and opposite alternating electric force, and a displacement current passes through the dielectric that separates *a* and *b*, varying, not only with the electric forces and the specific inductive capacity, but with the frequency of the alternations. There is no storage of energy. It is dissipated as heat, but this heat, with the very small amount of energy expended in telephone working, cannot be sensible. Taking the longitudinal action per unit length of each conductor, since there is no storage but only a small expenditure of energy between the conductors, the rate of fall of voltage must be slightly greater than that required by Ohm's law. It does not, however, cause retardation, because that is the result of storage and release of energy. It is different, however, with the condenser action between each conductor and earth. Here there must be some storage of energy, but, for the reason given, this must be small; and in an insulated system like a telephone circuit, and with a thick dielectric sheath, the effect may possibly be neglected.

The problem resolves itself into a practical question: What is the best form to give the cable with our existing experience and our available materials? My present solution is given in Fig. 6. The conductors are insulated

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first with paper and then with a thick coating of guttapercha. Paper only exists between the conductors. The cable is sheathed and compounded in the usual form. There are four circuits, instead of two, as at present in the London-Paris cable. With such a cable I have little fear of speaking between England and Germany, but to test the practical points that arise in the manufacture of such a cable it is proposed to make and lay a short one to the Isle of Wight. If my reasoning is correct, and so far experiment has confirmed it, then not only ought we to be able to speak to great distances, but the type of ocean cables must be revolutionised, for what is true for telephony would be equally true for telegraphy. Cables such as those across the Atlantic might, with the same weight of copper, be made to transmit a greater number of words per hour than they do now.

DISCUSSION.

Lord Kelvin had no doubt but that the construction shown in Fig. 6 would completely prevent the mutual disturbances in the cables, but he thought the capacity would be too much for practical purposes. In long cables the sluggishness would be greatly increased.

The **Author** said that if the frequency was not effected, good speaking might be obtained in spite of the retardation; but **Lord Kelvin** repeated that he thought the new form not so good as the concentric.

Prof. F. Bedell referred to the lack of symmetry in concentric cables, and to Mr. Preece's proposal to correct this by cross-connecting every few miles. He rather doubted the efficacy of this method and thought the effects might not be cumulative. It was rather like making lumps in one mile of road to correct holes in the previous mile.

Prof. Silvanus P. Thompson said that the advantages of the paper and air insulation did not consist merely in the difference of specific inductive capacity. The effects on the surface of the insulation when the cable was charged needed consideration, and this soaking in effect would be absent with air dielectric. He had some three years ago proposed to nullify the effect of capacity by artificial leaks distributed over the length of the cable. The method he proposed was to have two conductors, lead and return, in the cables, and to connect a third of high resistance between them at intervals.

Mr. Preece, in reply, agreed with Mr. Bedell that the crossing over of the conductors in concentric cable would not be possible with marine work. The air and paper insulation had great advantages over the guttapercha, both on account of the surface effect mentioned by Prof. Thompson and because the speed varied inversely as the specific inductive capacity. He would congratulate Lord Kelvin on the now universal acceptance of his law which first showed the truth of this. It was a fact that the heat used to heat up the dielectric relieved retardation, and he cited a case in which Prof. Vernon Boys had used strip conductors to increase the speed of signalling. He had often noticed that an increase in the possible speed of working had heralded a breakdown in the cables. The other points raised would be settled to some extent by the experimental cable now being constructed.

STREET-LIGHTING BY ELECTRIC INCANDESCENT LAMPS.*

BY WILLIAM GEORGE WALKER, M.I.M.E., A.M.I.C.E.

Having been consulted in reference to the installation of incandescent lamps in streets of several towns in this country and abroad, has led the author to communicate the following remarks. Street-lighting by the aid of incandescent lamps will probably receive serious consideration in the near future, principally in connection with the electric lighting of country towns and the by-streets of large cities. Great difference exists between the quality of the illumination required for the various streets of a large town. The payment of from £15 to £25 per annum for each arc lamp placed in the streets prohibits their use in the side streets, where the traffic is small. Arc lamps are undoubtedly the right thing for busy streets, but would prove an extravagant illumination for ordinary by-streets or roads of country towns. The difficulty has been only slightly met by placing the arc lamps at the corners of side streets running from the main ones. In side streets of large towns, and country towns where the population is scattered, the principal importance of the illumination is for the demarcation of the streets and roads. The light obtained from the ordinary gas-burner when placed at 50 yards apart is practically nil as an illuminant for the whole area of the street, yet its usefulness as a guide to traffic is obvious.

* Paper read before the British Association.

It may roughly be taken that the quality of the illumination necessary is of two kinds: firstly, where a flood of light is necessary on account of the nature of the traffic; secondly, where the light is necessary for the demarcation of the roads. The first quality has been met by the adoption of the arc lamp in series; it is the second which the author wishes to consider. At present very little street-lighting by incandescent lamps has been carried out in this country, and some of the few installations which have been put down have apparently only proved a partial success. It has, however, been tried with success on a fairly large scale in Brazil, North America, and on the Continent. It has been suggested that the current for the street lamps may be taken off the ordinary low-pressure mains that serve for house-lighting, etc. The current is not, however, laid in the majority of by-streets, and it will probably be many years before, if at all, it is adopted in all classes of houses; and even if a complete network of mains were laid for domestic and factory purposes there would be many objections to taking the supply from those mains, in addition to the inconvenience of switching each lamp in and out, as is the case with the ordinary gas lamp. Estimates show that the parallel system is generally impracticable on account of the comparatively great cost of the copper mains required to distribute small incandescent lamps in the streets. And, again, the overhead system would be debarred, on account of the weight of the cables. The parallel system becomes practical in congested districts and where natural water power can be obtained, as has been the case in several towns in Brazil, where there is abundance of natural water power, and also on the Continent.

It is due to the impracticability of adopting a "parallel system" of distribution on account of the cost and weight of the copper cables, that electric lighting has made so little progress in the lighting of side streets and country towns of this country. It has been felt that a way out of the difficulty was the adoption of the series system of distribution, whereby a small current may be employed running through all the lamps, allowing copper mains of small sectional area being used, thereby avoiding an expenditure on the mains. The number and candle-power of the lamps on the series circuits depending simply on the electrical pressure, the current being kept constant throughout the whole circuit (the voltage varying from a maximum at the positive terminal to a minimum at the negative one). The main difficulty against this system is that the failure of a lamp filament is liable to open the circuit and put out all the other lamps on the series, in spite of automatic switches.

The town of Temesvar, in Hungary, nearly 10 years ago adopted incandescent lamps for the lighting of streets with very satisfactory results; 750 16-c.p. lamps were originally put down on the multiple-series system—that is to say, in groups placed in series on the circuit, the lamps in each group being connected up in parallel. Each group consists of eight lamps in parallel, there being about 100 groups. In case of failure of a lamp, an automatic switch puts in circuit a resistance equivalent to the lamp. These appliances have been found to work well. The mains are overhead, fixed to telegraph posts, or to wooden arms let into the walls of the houses. The Municipality pay the company in whose hands the lighting is about £3. 10s. per annum for each lamp installed. During the first 1,200 hours of lighting only two out of 750 failed.

The series system of distribution with incandescent lamps has been installed in the parishes of Kingswood and Keynsham, near Bristol, and has shown considerable success during the 4½ years which it has been at work. As this is the only installation of its kind in Great Britain it may be interesting to give some details of the plant. The figures have been kindly supplied by Mr. Parfitt, the electrical engineer of the plant, and are up to the present date. At Kingswood about seven miles of roads and streets are lighted by circuits of two, two and a half, and three miles respectively from the central station. The lamps are spaced, roughly, at distances of about 60 yards, and are elevated at from 14ft. to 15ft. from the level of the road upon wood and iron posts, which also carry the

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wires overhead. The sizes of the lamps vary from 100 c.p. in the main streets to 35 c.p. and 25 c.p. in the side roads. The 100-c.p. lamps are switched out at 11.30 p.m., and other lamps of 16 c.p. are put in circuit. The smaller lamps are switched in before the larger ones are cut out, so that the continuity of the lighting is maintained. There are 150 street lamps, of which 16 are 100 c.p., 52 lamps of 35 c.p., and 60 lamps of 25 c.p. The indicated horse-power of the engine at full load is 32. There is a penalty clause in the agreement of 10s. per lamp for all defective lamps per night; and it says something for the regularity of the supply, and also for the good working of the automatic switch devices, that the fines for the last year were nil. The station plant comprises a compound Davey-Paxman horizontal receiver type of engine, which drives by belting three dynamos—a dynamo and its exciter giving 800 volts and 12 amperes—for the public lamps; also a shunt-wound dynamo at 130 volts and 50 amperes used for private lighting, together with a battery of 394 E.K.-E.P.S. cells, which forms a reserve against breakdowns. The boiler is of 16 nominal horse-power, Davey-Paxman type, working at 140lb. pressure. The mains which supply the high-pressure current (800 volts) are 10 and 14 S.W.G., and are insulated. They are carried by slings from steel bearer wires, strung from oil insulators in the usual way. The low-pressure circuits are of bare copper, Nos. 8 and 12 S.W.G., also strung from oil insulators. A device in connection with the magnetic cut-out and automatic switch has been contrived by which a local circuit is called into action, and a current is made to pass to the station from any defective lamps through the steel bearer wire, and so this is a constant resistance per mile run. The current passing through a suitably calibrated ammeter is an approximate indication of the position of the defective lamp. This current also rings a bell and calls the attention of the attendant. The revenue from the street-lighting is £650 per annum, supplied at an approximate price of 2½d. per unit. The cost of production is about £550 per annum, which includes a sum of 5 per cent. on the capital for depreciation, leaving a profit of £100. Coal, at 8s. 6d. per ton, costs per unit output 0·387d.—total cost per unit output, 2·1d. Lighting hours are 4,250 per annum, or from sunset to sunrise. The total cost of the Kingswood station and plant was about £3,500. The author understands that negotiations are now going on for extensions of the system.

The chief characteristic of this installation is the automatic cut-out devised by Mr. Parfitt, so that the failure of one lamp does not affect the lamps in series with it, but only that lamp, and that only temporary. The circuit is divided into two branches taking equal amounts of current. Each lamp has in series with it an electromagnet. A resistance is placed as a shunt to the lamp; so long as the armature of the electromagnet remains away from the magnet poles no current will pass through the shunt. The normal current of the lamps will not lift the armature, but when a lamp breaks the double current will pass through this allied lamp and through the electromagnet, which will lift the armature and complete the circuit through the shunt resistance, which is equivalent to the broken lamp. Should the second lamp break, the whole passes through the resistance.

Other devices might be used for carrying out a series system. The author's reason for calling attention to the one used at Kingswood is that it has worked satisfactorily during the past 4½ years, and that he himself has tested it under several conditions and found it act efficiently. On the breaking of a lamp the allied electromagnet appears to act simultaneously, and no apparent flicker was noticed in the corresponding lamp. The installation certainly goes to prove that the series system can be made a practical success, and that automatic devices may be constructed that can be relied on.

The Urban Board of Eston have recently received estimates and tenders for lighting the scattered district of Eston, Grangetown, and South Bank with 32-c.p. lamps. The estimates were for replacing each gas lamp with a 32-c.p. incandescent lamp; the estimates were very low, and the borough surveyor, Mr. Stanthorpe, informs the author that had not the private gas company granted them large concessions from their last year's contract they would have at once adopted the incandescent system for the lighting of the streets. As it is, he thinks it only a matter of time when his Council will do so. These estimates were for an overhead series system. It appears perfectly clear that a series system with overhead wires is suitable for scattered districts, and that it is as cheap as gas.

There appears to be considerable superstition among electrical engineers that a series system for incandescent lamps is difficult to manage. This opinion has been fostered by the apparent failure of one or two installations in this country, but it was not far to look for the cause of these failures, and which should not completely condemn the system. The Board of Trade may eventually require all high-pressure mains to be placed underground, in which case many of the advantages of the series system would disappear, as it would not perhaps be worth while to go to the expense of trenching for such light wires. Now that it is possible to obtain lamps suitable for a voltage as high as 250, and when used in conjunction with a three-wire parallel system, it may of course be worth while to pay for the extra cost of copper, as the system would undoubtedly be more convenient. Any increase in the voltage of incandescent lamps renders the parallel system more practicable, but even if it were possible to employ a 400-volt incandescent lamp arranged on the three-wire system, the dynamos working at 800 volts, the cost of copper mains would be about double of that if a series system were employed. A high-tension alternating two-wire system has been considered working at 2,000 volts, with a small transformer for each lamp, reducing the voltage in the secondary to, say, 200 or 250 volts; the efficiency of the small transformers would be of secondary consideration compared with any saving in the costs of the mains, and there would be no trouble with automatic switches.

APPLIED ELECTRO-CHEMISTRY.*

BY JAMES SWINBURNE.

LECTURE II.

The pressure needed to cause a given decomposition is frequently calculated from the thermo-chemical data given in pocket-books. As a coulomb decomposes a given weight of, say, salt, and as the combination of the sodium and chlorine which produce that amount of salt give out a definite quantity of energy as heat of combination when they form salt, it seems at first sight that by dividing the quantity of energy by the quantity of electricity we should get the pressure corresponding to the reaction. Broadly speaking, the pressure needed to electrolyse follows the heat of combination, but care must be taken not to take wrong data. The thermo-chemical data quoted in books on general chemistry are mostly taken from a four-volume book of researches by Thomsen, and are not always quoted intelligently. It is generally necessary to look up the context to see exactly what the author means. The heat of combination of, say, zinc and oxygen may be found on examination to be the heat of metallic zinc burning in gaseous oxygen. Allowance must in many calculations be made for the elements in compounds changing their physical state. Other reactions have taken place in a solution, a precipitate being formed, in which case heats of solution are involved. In working with data from Berthelot's book allowance must be made for the old notation. In many cases people totally misapply these data. For instance, in calculating the E.M.F. of a Daniell cell we are not really concerned with the heat of combustion of metallic zinc in gaseous oxygen, though it frequently figures in such calculations in spite of the fact that oxide of zinc is not formed. These thermo-chemical data should therefore not be used blindly, and should only be employed by those who really understand what they are doing. Chemical reactions do not necessarily take place so as to give out the maximum energy, however, so these thermo-chemical data cannot fit.

Suppose we have two primary cells; suppose at the temperature of the air they give one volt; imagine them coupled together, back to back, so that there is no current; suppose those cells, like most primary cells, have a temperature coefficient so that the electrical pressure given depends on the temperature; suppose that at a certain higher temperature the cells give 1·1 volts; let one be kept at this temperature, and the other at the temperature of the air: we then have 0·1 volt available, and there will be a current backwards through the cold cell. The chemical work is just the same in the cells,

* Cantor lectures delivered before the Society of Arts.

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except that all that is done in one cell is undone in the other. The capacity for heat of the whole cell is not altered by any changes in the compounds contained in it, as the specific heat of a compound depends only on the elements that compose it. We thus have a simple example of the pressure not being in accordance with the heats of combination, as the heats of combination would give the same pressure for the two cells. We can put a small motor in the circuit of the two cells, and get work done without any chemical energy being used up, as the chemical action is the same in the two cells. As this would otherwise mean perpetual motion, it is clear that the work done by the motor must be accounted for by heat disappearing somewhere in the circuit. The only place this can happen is in the cells. One or both of the cells must therefore be taking a continuous supply of heat from its surroundings and giving it out as electrical power. The cold cell cannot be taking heat from its surroundings, for if it were, and if the heat were converted into power, we need only wrap the hot cell in a non-conducting jacket, and the system would give perpetual motion. The hot cell must, therefore, be abstracting heat from its surroundings, and giving more pressure than its chemical reactions account for. Let us, therefore, divide its pressure in two parts—the chemical E.M.F., E_c, and the heat E.M.F., E_h. We can call the chemical and heat E.M.F. of the cold cell E'_c and E'_h, and the temperatures of the cells T and T', T being the higher temperature. Now the pressure of the hot cell is $E_c + E_h$, and that of the cold cell $E'_c + E'_h$, of which E'_c and E_c are equal. So the difference of pressure is due to the difference of E_h and E'_h. The difference in this case is taken as 0·1 volt, but that is merely an example. This difference, $E_h - E'_h$, is the available part of the pressure for motor or other purposes, and it is due to heat taken in at the temperature, T. As in such cases only a portion of the heat is converted into work—namely, T − T'/T, the available pressure, which is entirely due to the difference in heat E.M.F., as the chemical E.M.F.'s cancel out, can be given thus:

$$E_h - E'_h = \frac{T - T'}{T} E_h$$

Transposing, we get

$$E_h = T \frac{E_h - E'_h}{T - T'}.$$

If we imagine T to be infinitesimally above T', T − T' is dT and $E_h - E'_h$ is dE_h, or dE, as the increase is the same for the whole pressure the cell. We thus find that

$$E_c + E_h = E = E_c + T\frac{dE}{dT}.$$

This is Helmholtz's equation, put in a way that may be easy to follow. It shows that where a cell or a vat has a temperature coefficient the pressure does not follow the heats of combination, but depends on the temperature coefficient in a definite way.

If the hot cell had given less pressure than the cold one, the current would have been in the other direction; but heat must still be taken in at the hot cell and a portion of it given out at the cold one. If a cell has its pressure higher than the chemical actions account for, it must absorb heat on discharging and give it out on being run backwards, and *vice versâ*. If a cell has a negative coefficient its pressure must be lower than the chemical action accounts for; so, if the hot cell has the low pressure, it will be run backwards; but the work done by the current against the back pressure is too small to perform the chemical work, and the extra heat to be taken from the surrounding matter. It may be asked where the heat is taken up; whether at the anode or the cathode? Though the *locus* of the disappearance of heat is not necessarily the seat of the E.M.F. of a cell, this brings us to another question, which though of purely theoretical interest, as far as applied electro-chemistry goes, may be discussed, the novelty of the view taken being my justification.

Seat of the E.M.F. in a Cell.

There is not any. After so many able chemists and physicists have been discussing this question for so long it may seem rather bold to make such a statement as this; but to a great extent the question is rather one of definition. It is commonly taken for granted that, say, a point on a wire must be at the same potential as itself, but this is not necessarily so. Instead of thinking of an electric circuit, with which we are a little too familiar to be able to see clearly what I mean, let us take a magnetic circuit, that of the magnets of a dynamo for example. Imagine a "unit pole" at one pole-piece. Let it move over to the other; the work it does will be the measure of the difference of the magnetic potential of the pole-pieces. If the pole is still allowed to move, say, along a small hole in the iron, it will go round the field magnets to the point from which it started, and will then make another tour round the magnetic circuit, and so on. Each time its path is a complete circuit, which is interlinked with the electric circuit—that is to say, with the field-magnet windings. The work done on the pole in each cycle is 4 π times the current-turns in electromagnetic C.G.S. measure, or 0·4 π times the ampere-turns in the practical system. Imagine that the iron is perfectly permeable; then all the work will be done on the unit pole in crossing the air-gaps, and the fall of the potential across them will be 0·4 π times the ampere-turns. There will be no force acting on the unit pole on its way through the small hole round the iron of the field-magnet circuit. It will be seen that every time the unit pole goes round it falls 0·4 π n c units of potential, so that every time it passes a given place it has fallen that amount. In other words, any part of the magnetic circuit differs from itself in magnetic potential by 0·4 π n c. At any point the magnetic potential has an infinite number of values, differing by 0·4 π n c. If we consider that the unit pole falls a height of 0·4 π n c in going across the air-gaps, in order to make up for this fall it would have to be raised the same amount on its way through the iron; but we have specially assumed the iron to be perfectly permeable, and there is no force at all on the way through the magnets. The force there really is due to the iron not being perfectly permeable, is in the same direction as that in the air-gap. A unit pole describing a circuit interlinked with an electric circuit thus falls in potential. Its potential is not raised the same amount at some part of the circuit. If it were, there would be no difference of potential between the poles. There is thus no seat of the "magnetomotive force," to use a loose term that is fashionable; in other words, there is no sudden rise of magnetic potential in the magnetic circuit.

Now take an electrical conductor, say, in the form of an incomplete ring, and imagine the end of a magnet to be moving slowly through the ring, so as to generate E.M.F. Suppose the wire has no resistance, merely for the sake of simplicity, and suppose the magnet pole is large enough to produce a volt at the rate it is going. If the coulomb is allowed to go from one side of the air-gap in the copper circuit to the other, it will fall one volt in potential, the fall of potential being measured by the work done—namely, one joule. Ear mark the coulomb and let it go round the copper to the place from which it started. As we have assumed the copper to have no resistance no work is done in this part of the circuit, and if there were any work owing to the resistance of the copper it would be in the same direction as when the coulomb crossed the air-gap. If allowed to go in the direction of the E.M.F. the coulomb is always falling in potential. Every time that coulomb passes a certain point in the circuit it falls one volt. Each point of the electric circuit has, therefore, an infinite series of potentials differing by one volt. It might be said that this cannot be the case, because the potential of a point on the conductor is defined as proportional to the work done by a unit quantity of electricity moving from there to the earth, or to an infinite distance. But it can choose various paths, and if it goes round the magnet pole several times it will add or subtract a volt for each time it goes round. At first sight the analogy between the electric and magnetic circuits does not seem very clear. The moving magnetic pole, however, corresponds with a magnetic current. A magnetic conductor is unknown, but just as there can be a displacement current of short duration, or a convenient current in an electric circuit, so there can be a displacement or convection magnetic current. The moving magnetic pole in this case corresponds to a convection current; if it had been stationary, but had been an electromagnet with increasing excitation, we would have had a magnetic displacement current. If a magnetic circuit with a magnetic current is interlinked with an electric circuit, there is cyclic difference of electric potential round the electric circuit. If an electric circuit with an electric current is interlinked with a magnetic circuit, there is cyclic difference of magnetic potential round the magnetic circuit.

The analogy between the electric and magnetic circuits is not popularly understood as well as it ought to be, and its clearness has been very much obscured by the unfortunate use of the term "electromotive force" for difference of potential or potential instead of for the rate of decrease of potential. We have thus "electromotive force" as the line integral of "electric force"—a term not much used—and magnetic force remains as the rate of decrease of magnetic potential. Still further confusion has been produced by treating permanent magnetic displacement as analogous to an electric current, and permeability, which is really the analogue of specific inductive capacity, as magnetic conductivity. To make matters still worse, the term "magnetomotive force" has come in to denote magnetic potential, while magnetic force remains in the legitimate sense of rate of fall of magnetic potential. These absurdities have been approved by international and other congresses and committees, but the so-called work of holiday meetings of people with idle summers should not be taken too seriously. The idea of the interlinked electric and magnetic circuits and their analogy and of cyclic potential is fully worked out by Maxwell. Heaviside, however, has developed the subject very fully, making it the basis of his treatment of electromagnetic theory. I do not know if there are any Germans who do not read English as well as an Englishman reads German badly, but if so, they will, if I remember right, find the ideas of Maxwell and Heaviside developed by Föppl without Heaviside's special kind of algebra. The idea of a magnetic current is, I think, due to Heaviside.

(To be continued.)

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NOTES ON ELECTRIC CRANES.*

BY E. W. ANDERSON, A.M.I.C.E., M.I.MECH.E.

One of the earliest applications of electricity as a convenient medium for the transmission of motive power was to the driving of travelling cranes, and the fact that this, at that time, newly developed method of transforming heat energy into a subtle vibration and reconverting into work was so soon applied to this purpose shows that there certainly was a need for it. Now, after some 10 or 12 years' experience, it may be fairly stated that the system is not only a success, but is the very best method that has yet been devised.

The object of this paper is to give some of the experience the writer has had with electric cranes in practical use in the Erith Ironworks, trusting that it may be of general interest, while at the same time it is hoped that the discussion may elicit that of other users. A paper is to be read at the coming session of the Institution of Civil Engineers by Mr. H. W. Ravenshaw, on the application of electricity to cranes and lifts, in which it is understood a large number of figures will be given dealing with questions of efficiency, current consumption, etc., and for which the writer has supplied a certain amount of information. It would not therefore be quite fair to forestall this paper by giving any of this information now, and it is proposed to deal solely with practical points.

In May, 1888, Dr. W. Anderson, C.B., etc., then a member of the firm of Easton and Anderson, of Erith, conceived the idea of applying electricity to a 20-ton travelling crane in the foundry, and in due course this was carried out successfully. At the next meeting of the British Association he read a paper before Section G, in which this crane was described and illustrated, the results of some experiments with it being given as well. It is, therefore, not necessary to describe in detail the arrangements of this crane, as they may be found in that paper; but it will be sufficient to say that the several motions are controlled by gearing driven by three transverse shafts on the top of the girders, and which are themselves rotated in either direction at will from a longitudinal shaft through the medium of three nests of bevel wheels and friction clutches. The longitudinal shaft is driven by means of a double helical spur wheel and pinion from a five-unit shunt-wound motor made by the then existing firm of Elwell-Parker. Each motion has two gears by which fast and slow purchase may be given as desired. The shunt coils of the motor are always in circuit with the conductors, and the starting switch simply turns on the current through the armature and through the usual resistance coils, which are so arranged that they can be used to regulate the speed if necessary. The motor is started light—that is, moving only the longitudinal shaft—and when it has attained its proper speed the several movements can be independently worked in either direction as required. The conductor conveying the current consists of a piece of angle iron, having one face roughly ground up, fixed to the shop columns above the crane by means of wooden blocks, and upon which a brass contact-piece attached to the crane by a spring slides, while the return circuit is taken through the wheels on to the rails. The pressure used is 100 volts.

When first started there was, as might naturally be expected, some little difficulty and trouble. The friction clutches were not quite up to the mark, and had to be altered a little, and the fuses inserted in the dynamo circuit had an uncomfortable habit of melting at the most critical times, generally when a ladle full of melted iron was being manipulated. These mishaps at first raised some prejudice against the crane, but when they were got over by improving the clutches and by the simple expedient of putting in larger fuse wires and chancing a burn out, such prejudice gradually disappeared. The writer is aware that the remedy to the fuse difficulty is hardly one to be justified on scientific grounds, but practically it has proved quite successful, owing no doubt to the fact that the heavy currents are only on the armature for such a short time, that the heating from them cannot become destructive. The motor is frequently called upon to give 10 h.p. for a short time, and seems none the worse for it, while on one memorable occasion, when an accident occurred and prompt measures had to be taken, the crane is known to have lifted at least 35 tons, and to have been none the worse for it.

Shortly after this crane was started, and before it was quite in a satisfactory condition, a steam crane was purchased and set to work in the foundry on the same gantry, so that the two cranes could be admirably compared in a practical manner. It was of an ordinary type, having its own boiler, engine, and gear on the travelling crab, so that it was entirely self-contained. At the present time these two cranes are practically doing the whole work of the main bay of the foundry, and have been steadily running—except, of course, occasionally when under repair—ever since they were started. The result is, that while the electric crane was looked upon by the foremen and workmen with some little distrust at first, now it is much preferred to the steam one, and has all the most important work given it to do by preference. The atmosphere of a foundry provides an excellent test for the durability of electric machinery under trying circumstances, and in this case not only is there the dust and dirt arising from the foundry itself, but there is the steam and smoke from the other crane, which does not by any means improve matters.

When first installed considerable doubts were entertained as to the ability of the motor to work well in so trying a situation, but the practical result has quite dispelled any fears on that score. It is not easy to get any exact statement of the repairs that have been required, as no record has been kept of them, and the care of it has been through several successive hands; but it is found that they have been very small indeed, and much less than have been found necessary in the case of the steam crane. The friction clutches require occasional adjustment, and from time to time some new parts, while two new commutators have been fitted to the motor, and it was considered desirable to rewind the armature once, otherwise an occasional turning-up of the commutator and adjustment of the brushes has sufficed. The starting switch requires a little trimming now and then, and one or two new contact-pieces have been fitted. Of course, the other parts of the gearing have required attention as in all other cranes.

A great advantage which this electric crane possesses over the steam one is that the attendant has nothing to think of except his work and can give his whole attention to it. In the other case there is the fire and the feed-water to look after and be borne continually in mind, distracting attention from the work that is being performed, and even constituting a source of danger in case of its being neglected. Moreover, it is necessary for the steam-crane attendant to come to his work an hour and a half before general work begins in order to get up steam, and on Mondays this is increased to two hours, whereas, with the electric crane it is not required, as the dynamo supplying the current is driven by the main turnery engine, for which, of course, steam has to be got up by starting-time in any case.

An important matter in foundry work is to have complete command of the crane at all speeds, to be able to lift and lower at exceedingly slow rates, and by the smallest possible amounts, so as to be able to draw large patterns and put moulds carefully together. It has been found that the electric crane answers admirably for such purposes, thanks, no doubt, partly to the sensitive friction clutches, and partly to the resistances provided for slowing down the motor, and is much superior to the steam crane.

Having said so much as to its good qualities, one objectionable feature must be pointed out, and that is, the noise made by the first-motion gearing. In the first instance, the motor running at 1,200 revolutions per minute drove the longitudinal shaft by means of an ordinary cast-iron spur wheel and pinion having a ratio of 8¼ to 1. The rattle made by this was terrific, and as it was found that, owing to the narrowness of the space available between the crane and the shop columns, mortice gearing, which would of necessity be broader, could not be got in, it was decided to substitute double helical-toothed wheels for the straight-toothed ones. The result was not so good as might have been expected, and at first the noise was nearly as great; but after having worked a little, so that the faces of the teeth had worn into better order, it improved a little, but still was very objectionable. It was then suggested to block up the triangular spaces between the arms of the wheel with wood, in order to deaden the vibration, and this did a great deal of good, as it converted the sharp, noisy rattle into a dull rumble, which was much less objectionable, and in this manner the crane has worked ever since.

The foundry crane promised to be so successful, that in May, 1889, it was determined to adapt electrical driving to a 15-ton crane in the main bay of the turnery. None of the cranes in this department had, however, been arranged with a view to the ultimate application of power driving like that in the foundry, but were simply fitted with ordinary hand-gear, so that a different system altogether had to be adopted. The crane had its gearing all fixed to bearings attached to the main girders, and the load was lifted by a falling block and four-part chain suspended from a small travelling carriage running on rails in the bottom flanges of the girders. The cross traversing was performed by a pair of pitch chains attached to this carriage and passing over sprocket wheels geared to the handles. The hoisting barrel was fixed at one end of the girders, and suitably geared to the handles, an automatic brake for lowering being also fitted. The chain after leaving the barrel was carried over guide rollers to a pulley at the other end of the girders, from whence it passed to the travelling carriage and falling block, and was finally anchored at the gearing end of the girders. The longitudinal traverse was worked in the usual manner by gearing connected with the running wheels of the end carriages, the opposite sides being connected together with a cross-shaft. On each side of the main girders there was a wooden platform for the men to stand when working the various handles. It was therefore evident that in this case the simplest thing to do was to remove the handle shafts, substitute belt pulleys for

* Paper read before the British Association at Liverpool.

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them, and drive from three separate reversible electromotors placed on the wooden platforms.

The company had not at that time commenced the manufacture of electric machinery themselves, and therefore three "Manchester" motors of suitable sizes were obtained from Messrs. Mather and Platt, provided with jockey pulleys, so as to run with very short belts, and brushes arranged so that the armature might revolve in either direction, and were duly fixed, as described, on one of the platforms. On the other platform a framework was fixed carrying three reversing switches and resistances, each controlling one motor, and a foot lever connected with the automatic lowering brake was arranged conveniently for the attendant. The crane is worked simply by the manipulation of these three switches and the lowering lever, while from the position in which they are placed an excellent view of the work being done can be obtained. The crane is driven by the same dynamo that supplies that in the foundry, the voltage being therefore 100, and the hoisting, cross traversing, and longitudinal traversing motors are respectively 10-unit, 1½-unit, and 2½-unit machines, all being shunt wound, with a few series coils to assist them in starting under full load. The current is collected in a different way to that described for the foundry, the arrangement having been suggested and carried out by Messrs. Mather and Platt. Two bare copper wires about ¼in. diameter are suspended parallel to each other and about 8in. apart by means of earthenware insulators from every sixth roof principal, making thus a series of loops, each 60ft. long, extending all down the shop, a length of nearly 600ft., and with a moderate amount of sag given to them. A standard is fixed at the outside edge of each platform, and thus, as far apart as possible, directly under the two conductors, and each one carries two insulated brass plates, one under each conductor, and at such a height that except at the insulators and a few feet on either side of them the wires are able to rest upon them. The plates on the two standards, which are under the same conductor, are electrically connected together and to the switch frame.

It will now be understood that wherever the crane is, the conductors will be resting on one or other pair of the contact plates and sometimes on both; because, while at or near the insulators the conductors are held up clear of the plates, a few feet on either side they sag down so much that they come in contact with them, and the distance between the two sets of contacts is sufficient to prevent at any time both sets being in such a position as to be simultaneously clear of the conductors. By this means the supporting insulators are easily passed. The wires were not put up quite carefully enough in the first instance, and the crane used sometimes to stop from all the contacts getting clear at once, but a little readjustment soon put this right, and it has worked well ever since. This crane has worked very well always, and has given no trouble at all. Owing, however, to the motors being made to reverse, the brushes have to be placed on the horizontal axis of the commutator, and thus no lead is given them except that due to the small arc of contact, the result being that there is always some sparking, and the life of the commutators is less than in the foundry crane, where practically sparkless running is obtained. In the shorter time that this crane has been at work three new sets of commutators have been fitted. Likewise the switches, from being so much more used, require more repairs than that of the foundry crane, and recently it has been found necessary to put in a complete new set. With these exceptions, however, but little repairs are needed, as there are no friction clutches or anything liable to much wear. The conductor contact plates occasionally require renewal, but this is a very small matter, and the conductors themselves are in very good order. The system of driving the gearing from the motors by means of belts makes the working of this crane practically noiseless.

As already stated, experience has convinced the writer that, at any rate for travelling cranes, electricity is more satisfactory than anything else, and there can be but little doubt of its cheapness. It is not possible to make any actual experiments to determine the useful work done per hundredweight of coal or anything of that sort, to settle such a point as this absolutely; on account of the intermittent nature of the work and the variations of the power required, added to the fact that no measurement of the energy expended in traversing can be made at all, except at the motor itself, in which case the loss in the gearing must be assumed: and as the same applies to all similar cranes however driven; the comparative cost of different systems can only be arrived at by common-sense reasoning.

Electricity has the following economical advantages: the current may be generated by a highly economical engine, and, therefore, at the cheapest possible rate; the loss in transmission to the motors may be kept very small without serious initial outlay, as the distance of transmission is usually very small, and the motor will only use current in approximate proportion to the work it has to do. On the other hand, however, there is perhaps rather more loss in the gearing than in some of the other methods of driving, on account of the great reduction in speed that it has to effect. Compare now the self-contained steam crane, such as that in the foundry. Both boiler and engine are necessarily much less economical than need be used for electric crane driving, and it would probably be fair to say that a given power generated in this manner costs three to four times as much, though as a set-off against this the engine is close to its work, and the losses of conversion and transmission of the electric energy are avoided, as well as some of that in the gearing. The net result, however, must be considerably to the advantage of the electric system.

Attention has already been called to the necessity for the attendant to come an hour and a half before the crane is required in order to get up steam, and this, together with the expenditure of coal in getting up steam, makes a considerable extra expense, which is avoided where the cranes are driven from the main factory boilers. A small item of expense is also due to supplying the crane with the fuel and water, which, of course, have to be lifted up to it.

The comparison of electrically-driven cranes with those worked by other modes of transmission is more difficult, because all such methods may employ an economical engine as the generator of the power, and so far may place themselves on a par with electricity; but whether the transmission is effected by wire ropes, cotton ropes, or by a square shaft a large amount of gearing is involved which must always be running and absorbing power, no matter what kind of work the crane may be doing. The writer's opinion is that, while for short gantries such methods compare well with electricity from an economical point of view, for long ones, such as in the Erith works, they cannot approach it. Pictures to yourselves a shop 600ft. long having, on the one hand, either a square shaft continually running on one side of it with the numerous bearings requiring of course continual attention in keeping them properly oiled, or else a wire or cotton rope with the array of pulleys and their bearings required by it; and, on the other hand, two small copper wires suspended in the roof out of the way and requiring no attention whatever. In such a case there can be no question as to the best system.

As regards repairs, the writer is only able to give personal experience derived from a 20-ton crane driven by a wire rope in one bay of the high erecting shop at Erith. The longitudinal travel of this crane is only 120ft. It has been found that a new rope is required every year, and the cost of this, together with the splicing and putting up, comes to about £10, so that the expense on this score alone has probably exceeded considerably the electrical repairs on either of the electric cranes, taking an average over the eight years they have been at work. Obviously, if this rope-driven crane had the same travel as the others, the cost would be very much heavier.

It has been urged by some that a more skilful, and therefore better paid, attendant is required for an electric crane than for the ordinary types. The experience at Erith has shown that such is not the case, and any labourer of ordinary intelligence will very soon acquire what little special knowledge is needed to keep the electrical machinery in proper order.

In considering the general design of electrical travelling cranes, several points present themselves to which attention may be directed. Is it best to have one motor to work all the three motions, or a separate one for each? There is a great deal to be said on both sides of this question, and, taking it all round, the writer is disposed to think that there is not much to choose between them. The single motor is best from an electrical point of view, as it avoids the necessity of reversing, saves a good many connections, and gives only one high-speed machine to look after. On the other hand, it entails the use of friction clutches or their equivalent, and a good deal of gearing to properly control all the motions. The three-motor system is more economical in power, as the motors are never required to run light as the single motor has to, and therefore the small current taken under such circumstances is saved. The control may be effected entirely by switches, which are very easily worked, and may be even operated from below without anyone being on the crane at all. If two or three motions are being operated simultaneously, the speeds of them can be independently varied if desired, whereas in the single motor arrangement this cannot be done, as any variation of the motor of course affects all the motions equally. On the other hand, the motors require more frequent repairs, and there are three commutators and sets of brushes to wear out as against one in the other system—though, of course, each only does one-third of the work. The fact, however, remains that the reversing motor commutators wear out more quickly than the other even with the lesser work and with a much cleaner situation to work in.

A consideration that constantly arises in the application of electric motors is the best system to adopt for reducing their usual high speed to the slow one often required—as, for instance, in crane work. In the cranes that have been described, unquestionably the belt reduction is by far the best, not only for its noiselessness, but also on account of the absence of vibration, which is considerable in the case of the gear reduction. The motor of the foundry crane does not seem to have suffered much from this vibration, but cases have occurred where the jar of spur gearing has damaged armature windings, and it is therefore best not to run any risks, but use

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some other form of reduction gear where practicable. Mortice wheels, with wood teeth, are of course better than either ordinary spur or double helical gear. Worm gearing is often a very convenient means of effecting the reduction, and is much more economical when properly made than is generally supposed. The writer's firm have used it very considerably in cases where other forms of gear were not suitable. It should be enclosed in an oil-tight casing, so that ample lubrication of all parts may be obtained, while dirt is excluded. The worm should be, by preference, on the top of the wheel, as it makes it more easily accessible, and the thrust should be taken upon properly constructed ball bearings. The angle of the thread is an important factor in the economy of the gear, and, in common with all the other details, requires careful consideration to get the best results. As a matter of fact, it is found that for economical results a treble-threaded worm is about the best to use, while double thread and single thread of ordinary proportions are less good.

From some experiments that have been made at Erith, it may be taken that the efficiency—that is, the ratio between the output and the input—of an ordinary single-thread gear, including the losses in the thrust and the wheel shaft bearings, should not be less than 52 per cent., a double-thread gear should be not less than 68 per cent., while a treble-thread gear should be not less that 75 per cent. A better result still may be obtained from quadruple-thread, but it is not so generally useful and is rather troublesome to make. Better results than these have been obtained, and in one carefully-conducted trial with a treble-thread gear that had been running for some time and had worked all the surfaces into the best possible condition, the combined efficiency of an electric motor giving out about 9 h.p. and the worm gear, including the thrust block and shaft upon which the Prony brake for testing was fixed, was as high as 85 per cent. This, however, cannot be relied upon in ordinary practice, especially when the gear is new, and therefore the figures given above are to be recommended for general use.

Friction gearing is occasionally employed, and if properly made and adjusted is good, at any rate, for small powers. The best form that the writer is acquainted with is Hollick's patent, which has been successfully used for crane work, giving good efficiency, and which may be thus described: The shaft to be driven has a large flat-faced pulley keyed to it, while another similar but smaller pulley is carried by bearings in a swinging frame in such a manner that the two pulleys are in the same plane, but separated from each other a short distance. Round them an endless belt is tightly stretched. The motor is supported on a flexible base, and has on its spindle a pulley made of compressed paper with a perfectly flat face, the size being rather larger than the space between the two iron pulleys. The ratio of reduction is given by the ratio of the diameters of the large iron pulley and the paper one. By exerting a slight pressure on the swinging frame, the paper pulley may be caused to wedge itself between the other two with considerable force, and if the motor is set in motion, the two iron wheels will both be driven by the paper one, the smaller transmitting its power to the larger by means of the belt, which also takes the thrust and prevents any stresses on the bearings. By making the motor base flexible, the paper pulley adjusts itself so as to bear equally against the two iron ones. Of course, to get the best results, this gear requires careful design and manufacture.

It will be interesting to make a comparison between hydraulic power transmission and electricity as applied to crane-driving. There can be no doubt that the hydraulic system is a very simple and convenient one in cases where the power has to be applied from a more or less fixed position, and is especially suitable where the work to be done is fairly constant, as, for example, a crane that always has to lift approximately its full load. In such a case the power may be used to its full advantage, which with variable work cannot be the case, except by the employment of double and treble powered machines, which to a certain extent adjust the water expended to the work it has to do. In this respect electricity has an advantage, as the motor has an inherent power of automatically adapting the amount of current it uses to the work that is demanded of it, though not quite in direct proportion. The motor, therefore, adjust itself to all loads, while the hydraulic machine can only do so in steps, so that the former must be more economical. Moreover, the motor does this without the aid of any external devices, whereas the hydraulic machine requires a complicated and expensive arrangement to effect the result. But hydraulic power can often be applied in a much more direct manner than electricity, as the latter almost always requires the high-speed rotation of the armature to be converted into a lineal movement in the hoisting arrangement of cranes or lifts involving a good deal of gear, which is, as a rule, not needed by the former. It is evident, therefore, that every case must be judged on its merits, and that sometimes one form of transmission will be more suitable, and sometimes another. But in the case of the particular kind of machinery with which the paper has been more especially dealing—namely, travelling cranes—there can be but little doubt that the electric system is much more advantageous, mainly on account of the great difficulty in satisfactorily taking the high-pressure water to the moving crane, especially with such a travel as the Erith cranes, say 600ft.

A hydraulic travelling crane was made at Erith a few years ago for the new ranges of the War Department at Shoeburyness to general designs furnished by the Royal Engineers, and this is the only instance the writer knows of where this method has been used for a true travelling crane. The lifting was performed by a direct-acting hydraulic cylinder, which would, of course, use as much water to lift one ton as 150 tons, the maximum for which the crane was made, and the two traversing movements were actuated by a rotary hydraulic engine driving a system of shafting and gearing. The principal feature of interest was, however, the method of transmitting the power to the crane, which travelled over a gantry 130ft. long. At the centre of the gantry on one side was a large hose keel containing a coil of Sphincter Grip armoured hose, one end of which was coupled to a hollow trunnion, through which the water was admitted to the coil, and the other to a swivel coupling on the crane. The hose was about half the length of the gantry, and thus, according to which side of the centre the crane was, and to the direction in which it was travelling, so the hose coiled or uncoiled from the drum, arrangements being made by means of weights and gearing for the drum to coil up the hose as the crane approached it. The exhaust ran into a continuous gutter laid down all along the gantry. This arrangement worked well, but is clumsy and expensive. The hose requires occasional renewal, and the system could only be applied satisfactorily to short gantries. Contrast this with the simplicity of electric transmission over any gantry, no matter how long it may be, and the advantage will at once become apparent. Besides, it would not be easy to work more than two cranes over the same piece of gantry, one having its coil on one side and one on the other; while with the electric system any number of cranes may work off the same conductors and over the same gantry, provided only the conductors are large enough to carry the required current.

In conclusion, the author would like to say that the paper does not pretend to be in any way an exhaustive treatise on the subject, but he thinks that the few notes he has put forward are sufficient to show that he had good grounds for making the statement at the commencement that electricity was the best method of applying power to the working of travelling cranes.

LEGAL INTELLIGENCE.

ELECTRIC LIGHTING PAYMENTS.

At Cardiff Police Court on September 22 (before Councillor E. Thomas and Mr. L. Samuel) a claim was made against William and Nesley Pedlar, umbrella manufacturers, 113, Queen-street, for electric energy supplied.

Mr. W. H. Andrews (deputy town clerk), in supporting the claim, stated that this was the first case of the kind under the Electric Light Act, and the summons was issued to show that the magistrates had jurisdiction over electric light rents. The summons was taken out under the Electric Light Act, 1882, which incorporated Section 40 of the Gasworks Clauses Act, 1871, and gave them power to recover as a civil debt.

It was stated in evidence that on July 29 the sum of £9. 18s. 6d. was demanded, and payment was promised, but nothing had been paid. There was another sum of £6 4s. 10d. due, but that, again, had not been paid.

The **Magistrates** made an order for payment accordingly, being satisfied that plaintiffs could recover in the police court.

COMPANIES' MEETINGS AND REPORTS.

ELECTRICAL COPPER COMPANY, LIMITED.

The statutory general meeting of this Company was held on Monday at the Company's offices, 14, Sherborne-lane, E.C., Mr. H. M. Matheson (the chairman) presiding.

The **Chairman** said the meeting was a purely formal one, but he might inform those shareholders present that the patents had all been transferred to the Company. There had been applications both from Germany and the United States with reference to the disposing of their patent rights, but the Board preferred to await the results of the works which they were about to erect at Widnes before parting with any of those rights on the Continent or in America. They had secured suitable land at Widnes for the erection of the works, on a lease of 999 years. The plans of the works were nearly completed, engines and dynamos had been ordered, and, according to the dates when all the machinery should be delivered, they would be in operation early next year. The experimental works at Paris had been taken over by the Company. These were sufficient for the manufacture of commercial samples, and numerous such samples had been made and reported upon by experts both in England and on the Continent. Numerous tests had been made by Messrs. Kirkcaldy and other experts, which had proved the superior strength and quality of the copper made,

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A complete series of these tests was now being carried on, and certificates would be issued to enable engineers to judge of the suitability of the Company's copper for the purposes of their work. In reference to the preference shares, they had issued 100,000, and these had been allotted; but there were still 50,000 left, which might be issued by-and-by.

There was no resolution for the meeting, and the proceedings ended with a vote of thanks to the chairman, proposed by **Mr. C. Meyer** and seconded by **Mr. C. H. Hills.**

RAND CENTRAL ELECTRIC WORKS, LIMITED.

The report of the directors for the 15 months ended June 30 last states that the statutory meeting was held on July 30, 1895, since when three calls of 5s. each have been made in order to meet the payments becoming due to the contractors, Messrs. Siemens and Halske, for the erection of the works at Brakpan and the shipment of plant and materials for the main line and mine installations. During the period under review £116,306 has been expended in compliance with the obligations under the equipment contract. The directors have been able to place the sums not immediately required on deposit at satisfactory rates. The interest thus earned up to June 30 last amounts to £2,999 as it appears in the balance-sheet. The cession of all contracts entered into by Messrs. Siemens and Halske prior to the formation of the company having been duly completed and registered at Pretoria, the fully-paid 25,000 vendors' shares in respect of and in payment for such contracts were issued in April last. The political troubles in the South African Republic during the early part of this year have somewhat hampered negotiations for the supply of electric power. Contracts, however, for amounts aggregating about 1,200 b.h.p have been practically completed. Other negotiations are in progress, as a result of which the directors anticipate that the remaining available capacity will be placed. The total capacity provided for in the equipment contract is 2,100 b.h.p. The building operations at Brakpan (central station) were commenced about September 1, 1895, and up to the middle of August, the date of the last report to hand from Mr. N. J. Singels, the general manager, the iron structure for the engine-house as well as buildings and several houses for the staff, were completed. The engine-house has already been roofed for the greater part, and about half the walls have been covered with corrugated iron. The foundations for the boiler-house and the two first engines were also ready. The branch railway line from the Netherlands Railway to the central station is completed, and has already proved to be of good service, especially for the transit of the plant and heavy machinery. About 900 iron poles have been erected for carrying the main wire, which is to run from the Brakpan works to the Paardekraal Farm, and the laying of the wires has been commenced at the Brakpan end. The unfortunate labour conditions in the Transvaal during the first few months of this year have necessarily caused some unforeseen delay in the erection of the works. Some further delay has arisen owing to a recent railway accident at Boksburg, by which several parts of the machinery in course of transit were damaged, necessitating their replacement from Europe. No efforts however, are being spared towards completion of the works, and, considering the frequent troubles which mining companies at the Witwatersrand experience in connection with the transport of materials, the probable delay in the supply of power by the electric works may be considered as insignificant.

The annual meeting of the Company was held at Winchester House yesterday (Thursday), Sir C Rivers Wilson, G.C.M.G, C.B., in the chair. The report and balance-sheet were taken as read.

The **Chairman**, in moving the adoption of the report, said although the works were still in course of construction, it was anticipated that they would be completed and in operation very shortly after the date limited by the contract—viz., November 3 When at work their machinery would be capable of an output of 2,100 b h.p., and they had already concluded absolute agreements with 10 firms in the neighbourhood, who would require about 1,200 h.p., and operations were very far advanced with five other companies who would take about 600 h.p. The price agreed to be paid was £45 per horse-power, as estimated when the company was started, so he thought they would soon be securing good profits on their undertaking.

Mr. A. Brakhan, a member of the local board of directors at Johannesburg, gave a satisfactory description of the works, and spoke very highly of the Company's prospects and relations with the surrounding mines and other undertakings.

Mr. August Barsdorf seconded the adoption of the report, and it was carried unanimously.

Messrs. Alfred H. Märker and G. Zwilgmeyer were re-elected as directors; and the auditors, Messrs. Price, Waterhouse, and Co., were also re-elected.

A vote of thanks was passed to the chairman for presiding.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Paris.—For the electric lighting installation of the Collège Chaptal on August 29, the lowest tender is stated to have been that of Lacarrière et Cie.

Bucharest.—Tenders will be received at the Mairie, Bucharest, on November 16 for a water-power electric generating station at Grozavesti. There will be two stand-by steam-engines.

Leyton.—Tenders will be received by the Urban District Council on October 6th for installing the electric light in the public library. Particulars are obtainable at the surveyor's office, Town Hall, Leyton.

Madrid.—Tenders will be received on October 12 by the Direccion General de Correos y Telegrafos at Madrid for the supply to the Spanish Government of 60,000 telegraph insulators. The upset price is 1 peseta (9½d.), and a 10 per cent. security will be required.

Berlin.—The construction of an iron bridge at Gitschiner-und-Skalitzer street in connection with the electric tramway is open for tender. Application is to the Königl. Regierungs und Baurathes Bureau, Markgrafenstrasse 94, Berlin, and the date is September 28.

Villefranche-Lauragais (France).—The Municipality of Villefranche-Lauragais (Haute-Garonne) have invited competitive plans for a public water supply and electric lighting. Prizes of 1,000fr., 500fr., and 200fr. are offered, under the usual conditions, and schemes must be sent to the Mairie by October 10.

Cologne.—Tenders are required by the Municipal Authorities for the construction and working of electric tramways in the city of Cologne to an aggregate length of 20·3 kilometres (12½ miles). Specifications, plans, and particulars are obtainable for 10 marks (10s.) from der Registrateur B, des Oberbürgermeisteramt, Köln, Germany, and tenders must be in by November 6.

Madras.—Tenders are invited for the lighting by electricity of Government House, Madras, including the banqueting-hall and aide-de-camps' bungalow, and also for the lighting of Government House, Guindy, including the military secretary's bungalow. For particulars application must be made to the consulting architect to the Government, Chepank, Madras. Tenders will be opened on November 11, 1896.

Mayaguez (Puerto Rico).—The Secretary of State for Foreign Affairs has been informed by H.M. Ambassador at Madrid that the Spanish Government have invited tenders for the construction and working of a telephone system in Mayagüez, Puerto Rico. The date fixed for the consideration of tenders is October 8, and such particulars as have been received may be inspected at the Commercial Department of the Foreign Office between the hours of 11 and 6 daily.

Brussels.—Tenders will be received on October 21, at the Bourse Brussels, for installing the electric light at the Arlon Railway Station, including the offices and works. Particulars are obtainable at the Brussels Bourse. La Société national des chemins de fer vicinaux will receive tenders up to October 28 for the conversion of about 14½ miles of tramway in the suburbs of Charleroi into electric lines on the overhead system. Particulars are obtainable, price 1fr., from the office of the Société, Brussels, rue de la Science 26.

Leeds.—The Council require tenders for the supply and erection of No. 2 overhead travelling cranes for the engine-house of the tramways electricity generating station, The Calls, Leeds. Tenders, endorsed "Tender No. 8 for Cranes," must be sent in, addressed to the Town Clerk, Town Hall, Leeds, not later than 12 noon on October 13. Particulars, plans, and forms of tender may be had from the City Engineer, Municipal Buildings, Leeds, or from Dr. John Hopkinson, F.R.S., 5, Victoria-street, Westminster, S.W.

Blackpool.—The Tramways Committee of the Corporation require tenders for the construction of the Station-road, Dickson-road, and Warbrick-road tramways. The contract will include the laying of rails, points, etc., excavating, concreting, paving, and making good the roadway. The Corporation will provide all ironwork and setts. Drawings may be seen and specification and bills of quantities obtained on application to Mr. J. Wolstenholme, borough engineer, St. John's Market-buildings, Market-street, Blackpool, on deposit of £2, which will be returned on receipt of a bona fide tender. Sealed tenders to be delivered at the office of Mr. J. Wolstenholme, C.E., borough engineer, by 12 noon on 26th inst., addressed to the Chairman of Tramways Committee, and endorsed "Tender for Tramways." The person whose tender is accepted will be required to undertake to observe the standard rate of wages and working hours applicable to the particular trade.

Morley.—The Electric Lighting Committee of the borough of Morley are prepared to receive tenders for the supply and erection of the following plant. (The whole bound up in one specification; price £2. 2s., returnable on receipt of a bona fide tender): Section A—Boiler-house plant: Lancashire boilers and fittings, feed pump, etc. Section B—Engine-house plant: steam alternators and exciters, motor alternator, accumulators, steam and exhaust pipes, valves, etc. Section C—switchboard and instruments. Section D—overhead crane. Section E—underground work: cables and stoneware culverts. Section F—transformers and switchboards. Section G—arc lamps, posts, and accessories. Section H—meters. Tenderers are at liberty to tender for any section, but not for part of a section. The ground plans of plant and specification, with terms and conditions of tenders and contract, may be obtained at the offices of Mr. Robert Hammond, the consulting engineer to the Corporation, Ormond House, Great Trinity-lane, London, E.C., on and after Wednesday, September 16, on payment of £2. 2s. for each copy, which sum will be refunded on the return of the specification, filled up with a bona fide tender. Tenders, sealed and marked "Tender for Electric Lighting," must be addressed to the town clerk, Mr. R. Borrough Hopkins, at the Town Hall, Morley (Yorks), and be delivered on or before Wednesday, October 14.

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RESULTS OF TENDERS.

Dewsbury.—The Governors of the technical school have accepted the tender of Mr. Richmond Turner for an installation of electric light in the school.

Dantzig.—For the supply of incandescent lamps for the Royal Factory at Dantzig, R. Behrendt, Berlin, tendered at 49pfg. and 54pfg. for 16 c.p. and 35-c.p. lamps, and Pintsch Bros., Berlin, at 62pfg. For carbons, the Actien Gesellschaft vorm. Ch. Schmelzer, Nuremberg, tendered at 13pfg. and 10pfg. the pair, according to size. There were other tenders, which were not considered as the samples did not fulfil requirements.

BUSINESS NOTES.

Theatre-Lighting. — The Comedy Theatre is being fitted throughout with an installation of electric light.

Hoylake.—The District Council have resolved to make application for power to light the district by electricity.

Wimbledon.—The District Council have decided to apply for a provisional order for lighting the parish by electricity.

Stalybridge.—The Town Council have made application to the Postmaster-General to establish a general telephone call office in the borough, and to extend the telephone.

Cape Town.—The trial trips of the electric tramways have proved quite successful, and it is stated that a complete system for the town and suburbs will be laid down.

Cherbourg.—It is stated that the French Government have decided to put down plant for the annealing of armour plates by electricity on the Thomson-Houston system.

Bangor.—At the meeting of the Council a formal resolution was passed instructing the clerk to apply for an electric lighting provisional order in the next session of Parliament.

Perth.—The directors of the Highland Railway Company have, it is stated, sanctioned the proposed introduction of the electric light into the carriages running on the through trains between Perth and the North.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending September 20 amounted to £1,214, as compared with £1,239 in the corresponding week of the previous year, being a decrease of £25.

Southampton.—The negotiations by the Corporation for the acquirement of the electric lighting undertaking are now being carried on. The Local Government Board recently sanctioned the borrowing of £54,000 for the purchase.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ending September 18 were £2 317. 4s. 10d., compared with £2 045 4s. 8d. for the corresponding period of last year, being an increase of £272. 0s. 2d.

Brighouse.—At the meeting of the Town Council it was decided to affix the corporate common seal to an agreement between the Corporation and Mr. A. B. Brook electrician, Brighouse, for the sale and purchase of his electric lighting plant within the borough.

Simla.—According to information dated from Simla, August 29 last, out of 11 firms who applied to the municipality for full particulars relating to the electric lighting scheme, only two submitted tenders. Neither tender had at that date been accepted.

London.—Messrs. J. Mowlem and Co, the contractors for the Waterloo and City Railway, have undertaken the contract for the construction of the new line from the Monument to Islington for the City and South London Railway, and the work will be proceeded with forthwith.

Motorcars.—At the annual meeting of Palmer's Shipping and Iron Company, the Chairman stated that they had arranged to utilise a portion of the plant in the manufacture of cycles, and when the time was ripe for them they proposed extending the manufacture to motorcars.

City and South London Railway.—The returns for the week ended September 20 were £871, compared with £831 for the corresponding period of last year, being an increase of £40. The total receipts for the half-year 1896 were £10,887, compared with £10,147 last year, being an increase of £740.

Bexhill.—A letter from the parliamentary agents in reference to the steps to be taken with regard to the proposed insertion of a purchase clause in the Bill about to be promoted by the electric lighting company was read at the Urban District Council meeting and referred to the Highways Committee.

Armagh.—In the report of the meeting of the County Asylum Board which appeared in our last week's issue the tender of Messrs. Inrig and Chester, London, was wrongly stated as being that of Messrs. Twigg and Chester. The price quoted by this firm should also have been given as £1,891, and not £1,961.

Fort William.—A new feature of the agricultural show this year was an exhibition of electric motor power as applied to farm implements and for cooking purposes, given by the electric lighting company. The experiments proved quite satisfactory. A butter-making demonstration was also given, the separator and churn being worked by electricity.

Walsall.—The Electric Lighting Committee reported at the Town Council meeting that they had given instructions for the cable to be laid in Freer-street for a distance of 75 yards from Bridge-street, at an estimated cost of £45, and they recommended that an additional transformer, at a total estimated cost of £1,000, be fixed in the transformer station at St. George's Hall. This was agreed to.

Eastern Telegraph Company.—The directors announce the payment on October 15 of interest of 3s. per share, less income tax, being at the rate of 6 per cent. per annum on the preference shares for the quarter ending 30th inst., and the usual interim dividend of 2s. 6d. per share on the ordinary shares, free of income tax, in respect of profits for the quarter ending June 30.

Tunbridge Wells.—The Mayor, in commemoration of his year of office, has offered to completely instal the General Hospital with the electric light, and the governors have accepted the kind offer. The whole of the interior of the building is to be lighted, including the seven principal wards, the operating theatre, dispensary, and offices, while in the operating theatre the installation is to be of a very complete character.

Budapest.—The Hungarian Government has authorised the making of an electric railway between Budapest and Trieste by the Société de l'Industrie Electrique de Genève, which has deposited caution money to the amount of 3,000 000fl. in the Hungarian treasury. Starting from Budapest, the line is to follow the shore of Lake Balaton and then pass by Balaton, Fured, and Csakathurn, to terminate at Trieste. There are no considerable engineering difficulties to be overcome in this long line.

Eastern Telegraph Company.—The directors announce the payment on October 15 next of interest of 3s. per share, less income tax, being at the rate of 6 per cent. per annum, on the preference shares of the Company for the quarter ending September 30, and the usual interim dividend of 2s. 6d. per share on the ordinary shares, free of income tax, in respect of profits for the quarter ended June 30. The register of transfers will be closed from October 8 to October 15, both days inclusive.

Kidderminster.—On the recommendation of the General Purposes Committee, Messrs. Dyson and Co.'s bill of costs for business connected with the Council's opposition to the Kidderminster and Stourport Electric Tramway Bill, amounting to £34. 12s. 1d., was ordered to be paid at the last meeting of the Town Council. The Town Clerk, replying to a question, said he did not think the tramway would be commenced yet, as land had to be purchased and other preliminary arrangements made.

Appointments Vacant.—The Corporation require a thoroughly competent man as clerk of works for the foundation work in connection with the extension of the central electric light station, Bristol. Applications, stating age, salary required, and accompanied by copies of recent testimonials, to be sent to Mr. Frank Wm Prosser, secretary, Electricity Department, Temple-back, Bristol, by October 3.—The borough of Salford advertise in this week's issue for a good cable-jointer at £2 per week. Applications to be in by 30th inst.

Leicester.—At the meeting of the Board of Guardians the Lighting and Ventilating Committee reported that Mr. Hind had prepared an approximate estimate for lighting the Board room, committee-rooms, registrars' and clerks' departments with electric light, for the sum of about £60, which was recommended for adoption. The question was raised by Mr. Goddard as to the increased cost of the electric light as compared with the present mode of lighting, but there was no serious opposition to the proposal, which was eventually carried.

Dover.—At the meeting of the Town Council, Councillor G Fry asked when they were going to have a report from the Town Ward Committee in regard to the lighting of Biggin-street. Councillor Barnes said it would be ready next week. Councillor Fry said he was told that there was a committee of three—two were for electric light and one for gas. If that was the reason of the delay he hoped the town would not be kept waiting. Councillor G. Mowll said it was no such thing. They had asked the gas company and the electric light company for prices, and were awaiting them.

Huddersfield.—At the meeting of the Town Council the Electric Lighting Committee recommended that wirings and fittings for any person requiring electrical energy be supplied, providing the owner of the property undertook to repay the cost by annual payments with interest; but the recommendation was referred back in order that the committee might again consider the law relating to the borrowing of the necessary money. Alderman Calvert, the chairman of the Electric Lighting Committee, stated that for the half-year ended June 30 last there had been a deficiency in revenue of £116. 11s. 9d., as compared with £624. 0s. 11d. in the corresponding half of last year.

Brussels International Exhibition.—It is hoped that electrical engineers and manufacturers will readily respond to the invitation of Mr. James Dredge, executive commissioner for the British section of the Brussels International Exhibition of 1897, and co-operate heartily in the efforts that are being made to secure a fitting representation of the manufactures of this country. Firms who intend to exhibit should communicate with Mr. Dredge at once, as already a large part of the available space has been taken up by Belgian manufacturers, to say nothing of those from Germany, France, and the United States. Full information can be obtained from the offices of the British section at 35 and 36, Bedford-street, Strand.

Morecambe.—Mr. Parker, electrical engineer, attended at the meeting of the District Council and explained his scheme for lighting the district with electric light. He also produced plans of the system and of an electrical generating station to be erected upon the portion of Toddy Moss. Mr. Parker also produced estimate of the cost of construction of the works and report thereon. It was resolved that the sum of £26,000 be borrowed upon security of the general district rate, for the purpose of defraying the expenses of purchasing portion of the undertaking of the Morecambe Electric Light and Power Company, Limited, and that application be made

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to the Local Government Board for their consent to the Council borrowing the said sum of £26,000.

New Publications.—Mr. Gisbert Kapp has just completed the translation into English of his work "Transformers for Single and Multiphase Currents," and Messrs. Whittaker and Co. will issue the same in a few days. A series of electrical engineering design sheets by the same author is also being issued in England by Messrs. Whittaker, from whom alone copies can be obtained. The same publishers have in the press a work upon "Central-Station Electricity Supply," by Mr. Albert Gay, chief engineer, Islington Central Station, and Mr. C. H. Yeaman, chief assistant engineer at the same station. The work will be included in the Specialist Series, and will be fully illustrated.

Leatherhead.—Some remarks were made at the meeting of the Urban District Council on the question of Mr. Dearle's notice of motion for the next meeting, in which he proposes that application be made for a provisional order authorising the Council to supply electricity for any public or private use within the area of the district. Dr. Davis expressed the opinion that they were sufficiently protected, and that no company could establish the system of electric lighting there unless the Council passed a resolution permitting it. He could not help thinking that they had better leave the matter alone, as it would mean a great expense. The subject then dropped, the clerk stating that it would come up for discussion at the next meeting.

Incandescent Lamp Reflector.—The National Reflector Syndicate, of 21, Bridge street, Manchester, have sent us one of their patent incandescent lamp reflectors. It is simply a circular disc of bright metal about 2½in. in diameter with a hole in the middle to allow it to be fitted on to the stem of the incandescent lamp. It clearly must add to the amount of effective light, but the addition of 20 per cent. which is claimed for it is certainly a very outside estimate. The writer intends to try it practically to-night on the lamp over his desk. Anyone else who wishes to do so can get the reflectors at 1½d. each if he buys a dozen, so it is not an expensive affair; but if the syndicate can manage to sell them by the thousand at that price they ought be in for a good thing.

Aberystwith.—At the meeting of the Town Council a letter was read from 45 inhabitants of Bridge-street applying for an additional electric lamp, which they suggested should be placed near the Bridge-street entrance to Gray's-inn-road. It was decided that the matter should be referred to the Public Lights Committee for consideration. The Public Lights Committee, of which Mr. D. C. Roberts is chairman, reported that they had very fully discussed the present system of lighting the town, and, pending enquiry respecting the rearrangements contemplated, recommended that the present system should be continued. The committee had also considered the question of extending the gas-lighting to Penparke, but passed no resolution. The report was adopted. During the past four quarters the Corporation have spent £700 for electric and gas lighting.

Kensington.—The report of the Works and Sanitary Committee presented at the Vestry meeting stated that during the month of July 17 miles 665 yards of new overhead wire had been fixed, three poles renewed, nine miles of wire removed, and one pole removed. The following notices and plans had been received from the undermentioned electric lighting companies relative to extensions of their mains in the parish: Notting Hill Electric Lighting Company: Kensington Park-gardens; House-to-House Electric Light Supply Company: Old Brompton-road Collingham-road, Scarsdale-villas, Allen-street, Kensington-road, North-row, Warwick-road, Philbeach-gardens, and Lexham-gardens. An application had also been received from the London Hydraulic Power Company for permission to lay a short extension of their mains in Drayton-gardens, and this was granted.

Dewsbury.—At the quarterly meeting of the Governors of the Technical School, the Electric Lighting Committee reported that they had held several meetings, and having the sanction of the governors had arranged for the lighting of the classrooms, school of art, corridors, staircases. The installation, as decided on June 24, was to consist of 166 lamps of 8 c.p., 93 of 16 c.p., four of 50 c.p, and one arc lamp, and it was agreed to ask Mr. Mitchell, the borough electrical engineer, through the Town Council, to draw up the specifications for tenders; but on July 14 the committee decided to withdraw this application, and Mr. Lee, the secretary, was instructed to take steps for drawing up specifications, and to advertise for tenders. At the next meeting 17 tenders from firms in various parts of the kingdom were read, and these were ultimately reduced to three. Ultimately that of Mr. Richmond Turner, of Dewsbury, was accepted.

Shoreditch.—After a somewhat vigorous discussion the Vestry have adopted the following regulations in respect to the Hydraulic Power Company: "(1) That in future the surveyor or the Works Committee shall not give permission to the Hydraulic Power Company to lay further mains or make any new connections, but in all cases the permission of the Vestry must be first obtained. (2) That £1 per annum way-leave be charged the company per 100 yards of main that may be laid in future with the Vestry's consent, and 10s. for each connection whether to mains laid or hereafter to be laid, including the connection to Nos. 70 and 71, Paul-street, application No. 1,865, referred by the Vestry to this committee, and subject to the above alterations, the same conditions as now embodied in the existing agreements to be also imposed. (3) That where electric mains have not yet been laid in any streets, the Hydraulic Power Company be not allowed to lay mains under the footways of such streets."

Aberdeen.—A recommendation has been made to the Gas and Electric Lighting Committee of the Town Council and to the Harbour Board to light the quays with electricity, at an estimated cost of £9,336. The Town Council decided at their last meeting to grant the use of an engine and dynamo to the Great North of Scotland Railway for the purpose of lighting Ballater Station by electricity on the occasion of the arrival of the Emperor and Empress of Russia *en route* for Balmoral. The company were to pay all expenses and £5 per day for hire. The Finance Committee reported that they had considered a letter from the general manager of the National Telephone Company expressing regret at the Council's decision in regard to the company's application for permission to lay the main routes of their wires underground, and suggesting an interview on the subject, and that they had resolved to recommend that a reply be sent to the effect that the Council were of opinion that no good result could be arrived by such an interview. The report was adopted.

Bradford.—According to the *Bradford Observer*, the Tramways Committee have not yet decided what system of traction to approve for the proposed new routes. Horse-cars are out of the question for either of the routes; there is the strongest possible objection to the use of steam-engines; the employment of petroleum is not suggested at all; and up to now there has been great confusion of opinion as to the relative cost and merits of the various electrical methods. The committees are giving very special attention to the subject of electric traction, and have been placed in possession of reports dealing with every system yet tested in any part of the world. They have a specific offer for the working of the new lines from the Simplex Electric Conduit Syndicate, Limited, who wish an entirely new system of theirs to be put to a practical test on these routes, on such terms as will at the same time suit their purposes and leave the Corporation to take possession of the routes for themselves at any time if municipalisation should be thought advisable. It is not likely, however, that the Council will be troubled with the consideration of this matter until some time after the provisional orders have been obtained.

Rockhampton (Queensland).—We have received a copy of the half-yearly report of the Rockhampton Gas and Coke Company, Limited, which contains some very interesting figures. The report states that the working expenses of the electrical department were somewhat less than the preceding half-year, while the returns were rather larger. The electrical operations showed a profit of £279. 7s. 2d, which had been appropriated towards the payment of the interest upon the company's debentures, amounting to £300, leaving a difference of £20. 12s 10d., represented in the debit balance of the profit and loss account of this section of the company's business. The following profit and loss account shows the receipts and expenditure for the six months ending June 30 last: Dr.—Generating electric current, £520. 0s 2d.: management, etc, £64 1s. 6d.; printing, £8. 8s.; interest, £300; stationery, £11. 8s. 3d.; insurance, £25. 12s. 6d; rates and taxes, £3. 10s 6d.; private arc maintenance, £13 6s. 1d.—total, £946. 7s. Cr.—Electric current sales, £825. 4s.; sundries, £12. 17s. 8d.; electric light fitting account, £27. 10s. 6d.; interest, £17. 10s.; rental on electric light fittings, £42. 12s.; balance, £20. 12s. 10d.—total, £946. 7s.

Leeds.—A dispute has arisen between the National Telephone Company and their Leeds workmen. On Saturday the local management intimated that they would require their outdoor servants to work an additional half-hour a day—in other words, 53 hours a week, instead of 50, as at present—in order to make the conditions of labour uniform throughout the country. As no additional pay was suggested the men declined to work the extra time, and on Monday morning none of them put in an appearance until the usual time—7.30 a.m. Thus defied, the local manager refused to allow them to start, and the men adjourned to the headquarters of the Gasworkers and General Labourers' Union to talk matters over with Mr. J. Smith, one of the officials of that body. Later in the day Mr. Smith and a co-official had an interview with the local managers of the company, and it was arranged that the men should return to work on the old conditions pending instructions from the head office of the company in London. In addition to declining to work the extra half-hour daily the men request that they shall be paid time and a quarter for overtime on ordinary days, and double time for Sunday labour. They also request a certain allowance for walking to work at places more than three miles away. Between 80 and 100 men in the city are affected by the dispute.

Bolton.—For some time past there has been a growing demand for the electric light, and the recent decision to adopt the Brighton system of payment is expected to give a very considerable impetus to the work of the department. The Gas and Electric Lighting Committee have recently been considering the advisability of extending the works and plant, and at a meeting held a few weeks ago it was decided to apply to the Local Government Board for permission to borrow £35,000 to meet the growing wants of the town. Since then the electrical engineer, Mr. Ellis, has got out particulars, and at the last meeting he submitted an estimate showing that £25,380 would be required to provide the additional buildings, boilers, engines, switchboard, mains, meters, etc., necessary to the development of the department. It was pointed out that £44,620 had already been expended, this being an excess of £4,260 over the amount (£40,000) sanctioned by the Local Government Board. To meet this, and also to cover the expenditure on the proposed extensions, the committee decided to request the Finance Committee to authorise them to make an application to the Local Government Board for power to borrow a further sum of £30,000. This will bring the total expenditure on the Corporation electricity undertaking to £70,000. At the same meeting the electrical engineer submitted designs for the new arc lamps proposed to be placed at each corner of the Town Hall-square, one of which was selected,

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Stirling.—At a largely-attended meeting of ratepayers held recently a motion was passed unanimously requesting the Police Commissioners to carry into effect without delay the obligation entered into by them with the Board of Trade to introduce the electric light into the burgh, and at a meeting of the Police Commissioners, when the above resolution was submitted, Provost Kinross stated that there was no obligation resting upon the Commissioners to introduce the light, and it would, if carried out, simply mean a deliberate waste of public money. Exception was taken to this statement at the meeting, and since then a ratepayer has written to the Board of Trade calling attention to it, and asking an explanation of the position of matters. A reply has been received from the secretary, Mr. T. H. W. Pelham, stating that the order provides, *inter alia*, that the undertakers shall lay down mains in certain specified streets within a period of two years from the commencement of the order; that they shall apply electrical energy within the remainder of the area on certain specified conditions; and that if they make default in laying down mains in accordance with the provisions of the order, the Board of Trade may revoke the order. The order is dated 1895, and is scheduled under the Electric Lighting Orders Confirmation (No. 1) Act, 1895, 58 and 59 Vict., cap. 66.

Leamington.—At the meeting of the Town Council, the Watch, Lighting, and Fire Brigade Committee reported that the borough surveyor had submitted a report showing the comparative cost of various systems of lighting the Parade. The committee recommended that lamps, Sugg's 40 c.p., be put up in York-terrace, Lansdowne-place, and the lamp by Christ Church, with a view to adopting this system of lighting the Parade and Bath-street down to the railway bridges if it should prove satisfactory. Alderman Wackrill moved the adoption of the report, which he considered hardly said sufficient as to the gas-lighting of the Parade. Everyone would agree that it should be done better than at present. As to the electric light, they had received an offer which the committee had gone into fully, with the result that they considered the cost would be much greater than they felt justified in asking the ratepayers to furnish. The Council would probably like to know the relative cost of gas in comparison with the electric light. The company offered to supply 18 arc lamps, of 1,300 c.p., each to be replaced after 11 o'clock by two lights of 16 c.p. for the rest of the night. The cost would be £494. 3s. 4d., or if the large lights were kept on all night, £735. 6s. per annum. The difference in the cost of lighting by electric light and gas was from £494 to £207 per annum. The report was adopted.

Brighton.—The seashore electric tramroad seems to be meeting with a very hearty reception now it is completed. Mr. Magnus Volk writes to the *Sussex Daily News* as follows: "Will you allow me through your columns (as it is impossible for me to do personally) to thank the large number of residents and visitors for their kind wishes and congratulation upon the success of the Rottingdean electric railway. The problem as to its working is completely solved, and in the most satisfactory manner, any alterations as to speed and power being now simply a question of calculation. Many adverse circumstances during construction have made the last two years very trying ones, but I am amply repaid for my endeavours, though without the liberal help and support of my fellow directors (Mr. E. O. Blackley, Mr. J. J. Clark, and Mr. R. J. Pope) I must confess my own efforts would have been futile." The Lighting Committee have resolved that an electricity main be laid in Alexandra-villas at an estimated cost of £75, and that the public lamps in that street be lighted by electricity instead of gas. The letter from Mr. W. H. Tyler, requesting that additional lighting may be provided in the upper part of Stanford-avenue, was again considered at the last meeting of the committee, and it was resolved that two additional lamps be erected in Stanford-avenue. The letter from Mr. T. Dawes, requesting that public lighting may be provided in St. Andrew's-road, was again considered, and it was resolved that two lamps be erected in St Andrew's-road. The borough surveyor submitted a plan showing the lighting of Preston Park-avenue and it was resolved that an additional lamp be erected there. An application was submitted from the Technical Instruction Committee for permission for students from the York-place Technical School to visit the electricity generating station on December 19 next. It was resolved that the request be complied with. These proceedings were confirmed at the last meeting of the Town Council.

Catalogues.—We have received the catalogue and price-list of the voltmeters, ammeters, and measuring instruments of the Whitney Electrical Instrument Company. This company's works are in the United States and in Canada, but their agency on this side of the water is in the hands of the Stewart Electrical Syndicate, Limited, 103, New Oxford-street W.C. The meters cover both continuous and alternating current work, and it is claimed for the voltmeters and ammeters for alternating currents that their readings remain correct if the rate of frequency changes. The prices are quoted in dollars, not £ s. d., and there are code words provided for ordering instruments. Another agency of the Stewart Electrical Syndicate is the "Pioneer" arc lamp. This lamp is of the enclosed globe type, and it is claimed for it that it will burn 150 hours with one pair of carbons, and may be run either singly on 100 volt circuits or two in series on 200 volts. The makers suggest that these lamps are particularly adapted for street-lighting, since not only is there a saving in the cost of carbons, but also in the wages of trimmers.—The Standard Accumulator Company. 39, Victoria street, W., also send a catalogue of portable hand lamps, pocket accumulators, four-volt bicycle accumulators, cautery and lighting accumulators, etc. The illustrations are very clear, and full prices are given.—We have received from the General Electric Company, Limited, of London and Manchester, a copy of the supplement to their sixth edition telephone catalogue just issued. The first portion is devoted to prices, explanatory letterpress, and diagrams referring to their general intercommunication system and to accessories of the same, such as cable junction-boxes, etc. The special advantage which is claimed for this system is that the switch can be left in any position as last used and a call still be received. The second half of the pamphlet is devoted to the "Stanley" telephone, which has been brought out for ready connection to existing electric bell lines. Besides the ordinary wall combinations there is the commercial "Stanley" set and a combined telephone (transmitter and receiver), in the handle of which is a ringing and speaking key, enabling the ringing circuit to be switched out and the speaking circuit in or *vice versâ*, by a simple compression of the hand. The "Boudoir" and "Library" pattern instruments (the latter combined with a handsome two-bottle inkstand) are also fully illustrated.

Wimbledon.—The question whether the Council should apply to the Board of Trade for a provisional order in conection with the electric lighting scheme was discussed at the Urban District Council meeting. Mr. Donaldson said by getting a provisional order the Council would be able to keep the control of electric lighting in their own hands, but would it pledge them to go on with the scheme? The Clerk said no. Mr. Donaldson said he would move that a provisional order be applied for on the ground that if they did not do so they would practically leave the district at the mercy of anybody else who chose to apply. Mr. Olley seconded. Mr. Neller remarked that if a company had given notice that they intended to apply for an order, the Council would have to give some guarantee that they would go on with their scheme within a given period. He did not think they would obtain parliamentary powers for the sake of keeping everybody else out. The Clerk did not think they were bound to pledge themselves to a scheme before going for these powers. Mr. Fawcett said he had had some experience of the Board of Trade, and he knew that they would not grant a provisional order unless the Council showed them what they were going to do. The company would be sure to oppose their application, and if that was the case the matter would have to go before Parliament, and it would cost the town not less than £3,000 or £4,000. Even if the application was not opposed it would cost from £240 to £250, and the Board of Trade would give them a certain time in which to complete the work. If they were not going on with the scheme, would it be worth while to apply for the order? He thought it would be much better to let the company apply for their order, and make them insert such clauses as would protect them against that in regard to which they complained of the gas company. At least 80 per cent. of the ratepayers in his ward were opposed to electric lighting. It was a system of lighting that was quite in its infancy, and if they spent this money it was a great question whether it would not be entirely wasted. Mr. Williams said the weakest thing they could do would be to stand aside and let someone else create a monopoly. The science of electric lighting was in its infancy, it was true, but they did not know what improvements might take place and how it would be cheapened in the course of the next few years. Mr. Crickmay characterised the scheme as a speculative transaction from first to last, and said there was a very strong feeling in the public mind that it would result in loss. Still, if they had decided to adopt electric lighting, as business men they must apply for the necessary order. The Clerk, in answer to questions, explained that when the Council obtained their provisional order they would not be bound to go on with the work. He could not say what the cost of the order would be. The Council decided to apply for the order, Mr. Fawcett alone voting against the proposal.

Crewe.—A sub committee of the Town Council have been making enquiry into the question of electric tramways and their adaptation to the streets of Crewe. It appears that Mr. Sellon, a representative of the British Electric Traction (Pioneer) Company, Limited, attended a meeting of the committee and explained that his company were prepared to apply for an Act of Parliament or provisional order to construct a tramway in Crewe and to lay down and work the same provided that the Town Council and the property owners did not raise any opposition, and provided also that the tramway was an electric tramway, the motive power being derived from overhead wires. The sub-committee next caused enquiries to be made at Glasgow, Leeds, Bristol, Birmingham, Coventry, Blackpool, Hanley, Stoke, Walsall, and Hartlepool to obtain information as to the working of the tramway system in those boroughs. Every corporation applied to declared that the tramways in their respective towns were a great convenience to the town and to the public. The sub-committee said there was no doubt that the ideal tramway from the municipal standpoint was one constructed, maintained, and worked by the corporation. That was the opinion expressed by nearly all the corporations from whom the town clerk made enquiries. But however much some members of the committee might personally wish this plan to be adopted in Crewe, they were unanimously of opinion that at the present time such a scheme was practically impossible. By the erection of the sanatorium and technical school and other public works a large amount has been expended, and in face of this the committee did not think there was the slightest probability that the Corporation, or the ratepayers whom they represented, would sanction such a large capital expenditure (perhaps £50,000) as would be necessitated by laying down their own tramways, nor would they care to face the possibility of a loss on the working. That being so, there remained to be considered the question whether Crewe should remain without tramways or whether they should be laid down and worked by a company. The

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committee were, therefore, of opinion that if a responsible company were prepared to lay down and work tramways that their offer should be accepted. The British Electric Traction (Pioneer) Company, the committee considered, was a substantial and respectable company. The route of the tramlines suggested by the chairman of the sub-committee (Councillor C. H. Pedley) included a line from the Cross Keys, Coppenhall, in the north, to the railway station in the south; from the end of Victoria-avenue in the west to the end of Hungerford-road in the east; with a branch line from Mill-street, by way of Oak-street, Wistaston-road, and Victoria-avenue to Merrill's-bridge and another from the borough boundary at Wistaston along Nantwich-road to the corner of Mill-street. The sub-committee have come to the conclusion that a system of tramways in Crewe is much needed, and would be of great advantage to the inhabitants; that it is extremely improbable that the Town Council or the ratepayers would sanction the laying down of a tramway by the Corporation; that if a respectable and responsible company will at their own expense, lay down and work a tramway, it will be better to accept their offer than to do without tramways until the indefinite future time when the Corporation would lay them down; that the system of electric traction by overhead wires causes little or no disfigurement of the streets. The committee suggest that the Corporation should express its general approval of the proposal of the company to lay down and work an electric tramway in Crewe, and ask for the draft of the provisional order. When the Council get this, the question of the route to be taken by the tramway, etc., will be considered.

PROVISIONAL PATENTS, 1896.

SEPTEMBER 14.

20261. Improvements in electric hoists or capstans. William Harding Scott, Gothic Works, Thorpe Hamlet, Norwich.

20323. Improvements in telephone apparatus. Walker Moseley, 104, Lyndhurst-grove, Camberwell, London.

20339. Improvements in or applicable to phonographs. The Edison-Bell Phonograph Corporation, Limited, and John Hayton Greenhill, 191, Fleet-street, London.

SEPTEMBER 15.

20354. Improvements in electrical couplings. John Henry Tucker, 16, Oozells-street Birmingham.

20378. Improvements in holding and supporting imitation candles in connection with electric light fittings. Gustav Byng, 73, St. Stephen's-road, Upton Park, London.

20416. Improvements in or relating to electric alarm bells and like apparatus applicable to cycles and other vehicles. Alfred Julius Boult, 116, Hatton-garden, London. (Paul Archat, France.)

20419. Improvements in electric railways. Hippolyte de Romanoff, 23, Coleman-street, London.

SEPTEMBER 16.

20467. Improvements in and relating to quick-break double-pole switches and double-pole fuses for use in the controlling and distributing of electric light and power circuits. Herbert Henry Branson Deane, 104, Colmore-row, Birmingham.

20505. An improvement in electrodes for secondary voltaic batteries. Harold Imray, 28, Southampton-buildings, Chancery-lane, London. (Ralph John Walter Grindle, France.) (Complete specification.)

20513. Improvements in electromotors especially applicable to motor carriages and other vehicles. John Vaughan-Sherrin, 77, Chancery-lane, London.

SEPTEMBER 17.

20539. Improvements in electrical apparatus for signalling to or from a railway train or locomotive. Robert Burn, Alfred Charles Brown, and Leonard George Tate, 196, Green-lanes, Finsbury Park, London.

20579. Nicol's electric time-handicap starter. William Nicol, 60, Queen Victoria street, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, February 17, 1896, being date of application in New Zealand.) (Complete specification.)

20600 Improvements in and relating to electrodes. James Albert Deuther, 77, Chancery-lane, London. (Complete specification.)

20601. Improvements in and relating to electric furnaces. James Albert Deuther, 77, Chancery-lane, London. (Complete specification.)

20604. Improvements in electrical resistances. William Morris Mordey, 46, Lincoln's-inn-fields, London.

SEPTEMBER 18.

20707. Improvements in coating tubes by electro-deposition. James Greenwood, 4, South-place, Finsbury, London.

SEPTEMBER 19.

20745. An improved method of actuating switches or other controlling gear placed on or below the surface of the roadway in an enclosed conduit or other system of electric traction. Robert Pasley Stevenson, 7, Duddingston-park, Portobello. (Edward Henry Blathwayt Tyler, South America.)

20778. Improvements in safety attachments or devices for preventing the falling of suspended wires, cables, or conductors used for the transmission of electricity. John Aldworth and Joshua Shaw, 6, Lord street, Liverpool.

20796 Improvements relating to electric railways. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Robert Lundell, United States.) (Complete specification.)

20805. Improvements in devices for protecting electric circuits and apparatus or instruments from injury by excessive electrical potential. Valere Alfred Fynn, 47, Lincoln's-inn fields, London.

SPECIFICATIONS PUBLISHED.

1894.

23825*. Arc lamps. Brockie. (Amended.)

1895.

8210*. Magnetic needles. Gisborne. (Amended.)

9144. Electric soldering apparatus. Binswanger and Ball. (Amended.)

13958. Trolley systems of electric propulsion and in apparatus therefor. New.

16569. Manufacture of electrodes for voltaic batteries. Epstein.

20071. Conduits for electric railways. Philippi.

22234. Means for protecting electrical and magnetic apparatus against the disturbing effects of electric railways passing in proximity thereto Siemens Bros. and Co., Limited. (Siemens and Halske.)

1896.

10127. Conductors and collectors for electric railways and tramways. Leigh. (Keithley.)

10698. Electric time alarum apparatus. Bird.

10817. Electric brakes for electrically-propelled vehicles. Devonshire. (Potter.)

12183. Conduits for electric railways and tramways. Cope.

13889. Electrical distribution. Oppenheimer.

14014. Electric cooking and frying or roasting apparatus. Dymond. (The Chemisch Elektrische Fabrik "Prometheus" Gesellschaft mit beschrankter Haftung.)

15966 Electric arc lamps. Leitner.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5¼-5¾
Brush Company, Ordinary	3	1-1¼
—— Non. Cum., 6 per cent. Pref.	2	1½-1¾
—— 4½ per cent. Debenture Stock	100	110-113
Central London Railway, Ordinary	10	10¼-10¾
——	2	4⅛-4⅜
Charing Cross and Strand	5	9½-10
Chelsea Electricity Company	5	7¾-8¼
—— 4½ per cent. Debentures	100	114-117
City of London, Ordinary	10	16-17
—— 6 per cent. Cumulative Pref.	10	17½-18½
—— 5 per cent. Debenture Stock	100	131-135
City and South London Railway, Consolidated Ordinary	100	49-51
—— 4 per cent. Debenture Stock	100	136-138
—— 5 per cent. Pref. Shares	10	14¾ 15¼
County of London and Brush Provincial Co., Ordinary	10	8-9
—— 6 per cent. Cum. Pref.	10	13¾-14¼
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
Edison and Swan United Ordinary	3	1¾-2¼
—— 4½ per cent. Debentures	100	103-106
Electric Construction, Limited	2	1½-1¾
—— 7 per cent. Cumulative Pref.	2	2½ 3
Elmore's Copper Depositing	2	⅝-⅞
Elmore's Wire Company	2	⅜-⅝
W. T. Henley's Telegraph Works, Ordinary	10	18-19
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	3¾-4¼
—— 7 per cent. Preference	5	8¾-9¼
India Rubber and Gutta Percha Works	10	22-23
—— 4½ per cent. Debentures	100	107-110
Kensington and Knightsbridge Ordinary	5	9½-10
—— 6 per cent. Pref.	5	8¼ 8¾
Liverpool Electric Supply, Ordinary	5	8-8½
Liverpool Overhead Railway	10	13¼-13¾
—— 5 per cent. Pref.	10	17¼-17¾
—— 4 per cent. Mortgage Debentures of £100	100	112½-114½
London Electric Supply	5	⅞-1⅛
Metropolitan Electric Supply	10	12½-13½
—— 4½ per cent. First Mortgage Debenture Stock	100	120-123
National Telephone, Ordinary	5	7¼-7¾
—— 6 per cent. Cum. First Pref.	10	17-19
—— 6 per cent. Cum. Second Pref.	10	17-19
—— 5 per cent. Non. Cum. Third Pref.	5	6⅞-7⅛
—— 3½ per cent. Deb. Stock	100	107-110
Notting Hill Company	10	11½-12½
Oriental, Limited, £1 shares	1	1¾-2
—— £5 Shares	5	8¼-8¾
—— £4½ shares	4½	7¼-7¾
Oriental Telephone and Electric Company	1	¾-⅞
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	105-107
Southampton Electric Company	5	4¾-5¼
St. James's and Pall Mall, Ordinary	5	11½-12½
—— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	40-43
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	—	8¼-8¾
Westminster Electric Supply, Ordinary	5	11-12
Yorkshire House-to-House		7½-8

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NOTES.

The North-East Engineers.—We have to acknowledge the receipt of the *Transactions* of the North-East Coast Institution of Engineers and Shipbuilders.

Belgian Telegraphs.—The jubilee of the establishment of the telegraph in Belgium has been celebrated by a largely-attended meeting at the Palais des Académies. The Minister of Railways presided.

Society of Engineers.—A meeting of this society will be held at the Royal United Service Institution, Whitehall, next Monday (October 5), when a paper will be read on "Discharging and Storing Grain," by Mr. William G. Wales, A.M.I.C.E.

"Electric Power."—We learn with regret that the issue of *Electric Power* is to be discontinued. It was an American monthly magazine, established in 1889, and in the quality of its matter compared most favourably with a great many of its contemporaries.

Breakdown.—There was no performance of "The Sign of the Cross" at the new Brixton Theatre on Tuesday, owing, it is stated, to a failure in the electric lighting arrangements. The installation is a private one, with engines and dynamos in duplicate. The precise nature of the breakdown was not made known.

Block Signalling.—In company with most of the rest of the Press, we stated last week that the late Mr. John Warwick was the patentee of a system of block signalling. Mr. Warwick's patent appears to have been one for "arranging and combining apparatus for the purpose of indicating whether the light of a semaphore or other railway signal is or is not burning, such purpose being effected by means of a piece or pieces expanded by the heat of the light, and contracted when the light is put out," thereby making or breaking an electrical circuit which actuates mechanism for giving audible signals.

Electric Gas-Lighters.—It is one of the troubles of the Welsbach mantle that, if you are not particularly careful how you light the gas, you break it or blow it to pieces with the explosion. The task is beyond the power of the ordinary street lamplighter with his pole, but, of course, the problem can be avoided. The favourite way is to keep the gas always alight with a by-pass, with the result that it occasionally gets turned on at mid-day with the crook end of a walking-stick. In the South of France they have fallen back on electricity, the spark that ignites the gas being produced by an induction coil and a dry battery. Quite a quantity of gas lamps are said to be so lighted in Toulouse. There is, of course, nothing new in the idea.

Paris Exhibition (1900).—The *Bulletin* of the French Society of Civil Engineers opens with a "note" by Mr. C. Labro on the forthcoming Paris Exhibition of 1900. A great deal of space is given to the classification of exhibits, which, it appears, is not to be geographical, but according to the nature of the exhibit. Mr. Labro thinks very highly of it, apparently because, of 18 groups containing from two to eleven sub-classes, the group of "education" comes first and military and naval exhibits last. Electricity is number five, but as the arrangement is not one of merit and dignity in any way, it does not seem what there is to insist upon in the position of any one group. As for the sub-classes in Group III. we have such incongruous matters as printing, theatres, music, medicine and surgery, coins and medals, all brought together. It has apparently passed the wit of the compiler of the classification to find a descriptive title for this group.

Steam-Turbines.—Prof. J. H. Barr has contributed an article to *Cassier's Magazine* on the subject of steam-turbines. After some historical matter, including our very old friend, Hero of Alexandria, Mr. Barr refers to the ordinary cylinder steam-engine and the loss due to transfer of heat from the steam to the cylinder wall and *vice versâ*, the mitigation of which is the justification of the compound and triple expansion engines. Mr. Barr says the steam-turbine is entirely free from any loss corresponding to this. If "entirely" has any meaning, this is, to say the least, doubtful. The Parsons, Dow, and De Laval types of steam-turbine are briefly compared, but there are no tests made under precisely similar conditions. The conclusion, however, is that the steam-turbine is a form of engine that will have to be reckoned with in electric lighting work at no distant date.

Cable Interruptions.—From the official list of telegraphic cable interruptions published in the Berne *Journal Télégraphique* communication had not been re-established on September 25 over the following cables: Loanda and Benguela (failure September 13), Penang and Medan (September 7), Bahia and Rio de Janeiro (September 4), the Equadorian land lines (August 11), the Para-Maranham cable (August 6), the Salisbury and Umtali line (July 11), the Columbian (New Grenada) land lines (July 4), part of the Amazon Company's cable (May 4), the Trans-African line beyond Mazoe (March 11), and the Puerto Plata and Martinique cable, which dates its failure from last December. During the month there were five failures on Siberian lines: all were repaired within the day. Besides short interruptions on the Florida and Saigon and Bangkok land lines, the only other interruption noted is that of the Zanzibar and Mombassa cable from August 23 to September 5.

Herz Wave Telegraphy.—We last week referred to the remarks made by Mr. Preece on the subject of experiments made under the auspices of the Post Office on Mr. Marconi's method of transmitting telegraphic signals by means of Herz waves, the details of which, however, were not disclosed. At the finish of the British Association, Prof. Oliver Lodge invited the members of Section A to witness in his laboratory an experiment in which, at an hour's notice, his assistant had arranged apparatus to do an exactly similar thing. Prof. Lodge expressed some regret that the resources of the Government should be open to foreigners, instead of encouragement being given to workers in this country. It may be worth mentioning that one of the points of using the Herz waves for this work, rather than, say, an ordinary heliograph, is that not only are they invisible, but if experiments at Cambridge are to be depended on, such things as brick walls or a house or two in the way would be no obstacle to the transmission of signals.

Royal Photographic Society.—The division of the photographers into three groups is somewhat of a puzzle to outsiders, but the Royal Photographic Society still represents the original foundation. Its annual exhibition at the Royal Society of Painters in Water-Colours' Gallery in Pall-mall East, was opened on Monday, and will remain open until November. It is stated that the total number of pictures submitted to the Selection Committee was above 1,100; but of these, owing to more rigorous selection, 354 have been hung—or about 100 less than is usually the case. This reduction is the result of the aim of the committee to increase the value of the selection of a picture

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for hanging by raising the standard of work required. On Saturday evening there was a soirée in the gallery, a very large number of members of the society and their friends being present, the company including Sir Trueman Wood, Prof. Hatton, and Messrs. A. L. Anderson, Scammell, Marchant, Hertslet, Debenham, etc. Besides the photographs, there was an exhibition of cameras and other apparatus, acetylene lantern burners, and a demonstration of the Röntgen radiations.

Midland Mining Engineers. — At the general meeting of the members of the Midland Institute of Mining, Civil, and Mechanical Engineers last Saturday, at Sheffield, Mr. G. B. Walker, president of the institute, occupied the chair and delivered an address on the education of mining engineers. The mining students of this country, he said, did not usually receive a satisfactory technical education. He submitted that a mining student should be trained in the art and practice of mining, physics, chemistry, geology, machine construction and drawing, steam and steam-engine, electrical engineering, surveying, and mining jurisprudence, and in each of these he should have a thorough, not a superficial grounding. All that is a good deal for a student; but what Mr. Walker really wants for him is "to begin with two years at a colliery" (time to forget all he learned at school), "three years at a technical college" (learn it again), "two years in a colliery underground again, and one year in a colliery office." "A youth with such a training would be certain to be turned out thoroughly competent, capable of eventually filling the highest posts." This confidence that education will do anything provided you only arrange the taking of it in a new and uncongenial way is very touching.

Evening Classes.—The advanced evening classes in science which have been arranged for the coming session at University College and King's College, London, were mentioned in these columns last week. The courses are to be of the same standard as the day courses, and admission will be confined to students who have already made some advance in the knowledge of the subjects. The following are the subjects and times of the classes at University College, Gower-street, W.C.: Mechanical engineering (Prof. Hudson Beare)—Mondays, 7.15-9.30 (commencing October 12); electrical engineering (Prof. Fleming)—Tuesdays, 7.15-9.30 (commencing October 13); practical chemistry (Mr. C. F. Cross)—Fridays, 7.15-9.30 (commencing November 1). At King's College, Strand, W.C., the classes are: Civil engineering (Prof. Robinson)—Mondays, 7-9 (commencing October 5); architecture (Prof. Banister Fletcher)—Mondays, 6-9; and Wednesdays, 7-9 (commencing Oct. 7); experimental and practical physics (Prof. Adams)—Mondays, 6-7; and Wednesdays, 7-9 (commencing October 5); and pure mathematics (Prof. Hudson)—Tuesdays, 7-9 (commencing October 6). Application to join any of the above classes should be made as soon as possible to the professors who will conduct the courses. The fee for each course is £1. 1s.

Electric Light in the Far North.—Some particulars have been given in the *Elektroteknisk Tidsskrift* as to the running of the wind-driven electric light installation that was fitted up on Dr. Nansen's exploring vessel, the "Fram." Windmill pumps are common objects on Norwegian timber ships, but the application of a similar method to charging accumulators on shipboard is somewhat of a novelty. Moreover, to take such an apparatus straight away to the Arctic Ocean is certainly trying it high. Nevertheless, it appears that the apparatus worked satisfactorily while the "Fram" was icebound, until in May of last year, owing partly to the wearing out of the gearing of the toothed wheel in the windmill which worked the dynamo, and partly to the fact that portions of the apparatus were required for making snowshoes and runners, the apparatus was dismantled. But up to that time advantage had been taken of every puff of wind to charge the accumulators, so that the electric light was always available when required. It is interesting to note that in the severe cold the accumulator cells froze, but the acid-blended ice proved an excellent electrolyte, and the frost did not interfere with the working. Of course, sufficient current was not available for the ordinary lighting, but an arc lamp run from the accumulator was used by Dr. Nansen when painting or photographing.

The Radiophone.—There is a report from America that Prof. Alexander Graham Bell is devoting his attention to the development of his radiophone with a view to making it a commercially practical instrument. The radiophone was devised nearly 20 years ago, and it will be remembered that the principle of it is to utilise a beam of reflected light for the transmission of sound between distant points. The transmitter is made up of a thin diaphragm, silvered at its back so as to make of it a reflecting mirror, and is connected with an ordinary speaking-tube, into which the operator talks as he would talk into the transmitter of a telephone. Against the diaphragm is projected a ray of light. If this is sunlight, it is received by a mirror and directed through a concentrating lens at whose focus is the transmitting diaphragm. The latter reflects the ray through a second lens, which makes the components of the ray of light again parallel, so that it may travel any distance without dispersion. At the receiving station there is a parabolic reflector, at the focus of which is fixed a selenium cell. The cell in turn is connected with a telephone circuit. The rhythmic deformations of the transmitter diaphragm produce a scattering of the usually parallel beam of light, with a consequent variation of its intensity when projected on the selenium of the receiver. Any resulting variation in the conductivity of the latter affects the telephone circuit.

Motorcarts. — When the third annual race for "automobile" vehicles from Paris to Marseilles and back, a total distance of 1,051 miles, was started last Thursday, 32 motorcarts put in an appearance, of which two had steam power, the rest using petroleum. It was an expert's opinion that not more than four or five of the vehicles would complete the journey to Marseilles and back, as in the majority the machinery was too complicated and delicate to stand the constant vibration inherent in the petroleum-motor system and the rough work to which they would be subjected in the long race. About the first thing done was to run over a man (man hurt). Next day a fallen tree was run into (cart hurt). On the third a dog in the way caused a capsize of a motorcart (rider bruised). Ultimately, 14 of the motorcarts got to Marseilles, so the expert's opinion will probably be out by a large percentage. The final is not to hand at the time of writing this note. In America, one of the features of the Rhode Island State Fair at Narragansett Park recently was a competition of horseless carriages or motor cycles on a trotting track. Of 12 entries, seven contestants started. Two of the vehicles were driven by electric motors and the others by gasoline. The fastest mile was made by the carriage of the Riker Electric Motor Company, of New York—two minutes 47½ seconds. On a second day's trial one of the Duryea motor carriages developed sufficient speed to hold second place, the Riker machine coming in first, and the Electric Carriage and Wagon Company's vehicle third. The time was 14 minutes 33 seconds for the five miles.

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Light Railways.—Last week we noted that the Board of Trade would allow a month's delay this half-year in the date for the submission of schemes under the Light Railways Act. We have received a letter from Mr. Sidney Morse on the subject, pointing out that this month's grace applies to the preliminary advertisements which have to be made in the local papers as well as to the submission of the schemes to the Board and the county authorities. To make it quite clear, we may repeat that under the rules notice of intention to apply for an order must be published by advertisement in each of two consecutive weeks in November next in at least one local newspaper circulating in the area through which it is proposed to make the railway. The notice must describe generally the line of the railway, its termini, the lands proposed to be taken, and the gauge and motive power of the railway, and must be subscribed with the names of the promoters. It must also name a place where a plan and section of the proposed works—with a book of reference to the same—and a plan of the lands to be taken may be seen. Copies of the draft order, plans, book of reference, section, and estimate of cost of contract must be deposited by the promoters during the month of December with the clerk of the county council, and of every borough, district, and parish council through whose area the railway is proposed to be made, and also with the Board of Trade. Copies of the draft order must be deposited with the Treasury, the Board of Agriculture, the Postmaster-General, the Commissioners of Customs and Inland Revenue, the Admiralty, the War Office, the Office of Woods and Forests, and the Office of Works, and, in the case of proposed railways in Scotland, with the Secretary for Scotland. The fee payable by the promoters to the Board of Trade before lodging any application is fixed at £50.

Power Transmission in Spain.—We have before now called attention to the progress of electric lighting in Spain. The following is an interesting example of the utilisation of a distant water power. The generating station which supplies current to Gandia and Alcoy, in the province of Valencia, is situated at the foot of a range of hills about half-way between those two places. The power is derived from the River Serpio, which winds along the foot of the hills. Though the stream has a considerable fall, this is by no means concentrated at one point. Consequently it has been dammed, and a channel cut along the side of the hills, into which a portion of the stream is diverted. After running for about 1¼ miles, the difference in level between this channel and the original bed of the stream amounts to a little more than 100ft., and at this point the generating station is erected. This contains two horizontal turbines, the water coming to them from a reservoir above through cast-iron pipes. The 110-kilowatt Siemens alternators are directly coupled to the turbines. They are wound for a voltage of 6,500 at the terminals, with a frequency of 50 cycles a second. The switchboard contains the usual fittings for high-tension work and synchronising the alternators. The line is an overhead one of bare copper, with oil insulators carried on wooden posts. The same posts carry the telephone wires between the generating and distributing stations. Alcoy is about 22 miles off the generating station, and the line drop exceeds 14 per cent. of the voltage. The local authorities absolutely refuse to allow extra high-tension currents to come into the town, so the first transforming station is some little way out. Here five Siemens transformers take down the voltage to 2,000, at which pressure the current is conveyed by an overhead line to a second transforming station in the centre of the town. This is an insulated cable line. At the town station the current is further transformed down to about 115 volts for distribution for lighting purposes. There are some motors, but these are fed from the primary by transformers of their own. The arrangement at Gandia is similar to the one above described at Alcoy, but smaller, due allowance being, however, made for the fact that the distance of Gandia from the generating station is not so great, and hence the line drop is less.

Telegraphic Topics.—An anonymous correspondent in the *Times* has discovered an Indian grievance which, so far as we know, has escaped hitherto the notice of the congress Babus. It appears that an Indian telegraph clerk is permitted to be ignorant of all alphabets but the Roman, and for all the Administration cares might be as unable to tell the difference between Sanskrit and Arabic as an eminent lady novelist who writes nonsense about electricity. In India, the correspondent is told—he does not seem to have been there—" all native telegrams must be translated, and retranslated on arrival, or must be written in Roman letters." He apparently wants the Arabic alphabet used. It is not a nice one for telegraphic work, but it is used in Turkey and Persia for languages that are really as alien to it as the Urdu. The trouble probably is that the users of all the other Indian alphabets would immediately want them adopted also. The ground would at once be taken away for rejecting Hindi in the classical devanagari script or Burmese and Southern Indian telegrams in alphabets that look as though they were written with a circular punch. So that instead of one grievance there would be three, with a prospect of more to follow. A more practical matter for English readers is dealt with by another correspondent. It is, that if anyone "notifies to the Post Office his change of address, but does not specially notify it to the telegraph branch of that office, telegrams will not be sent to his new address, though letters will be. Surely, as the office for delivering telegrams is under the same roof as that for delivering letters, the public have a right to demand the common-sense proceeding—namely that one notification shall suffice for both letters and telegrams." It is a well-known law of nature that an official cannot do anything unless someone fills up a form, but the public might have been told that two forms were necessary.

Impressions of a Telephone Exchange.—A representative of the *Porcupine* has been to see the telephone girl in her stronghold at the Liverpool Telephone Exchange. Mr. Martin, the district manager, took him, so he was not afraid. Even without adopting the theory of some subscribers that the telephone young lady has really a mission to avenge the historic wrongs of womankind on a business and therefore masculine world, one might reasonably be alarmed at the prospect of having to understand and describe intelligentlly a telephonic switchboard. This is what the *Porcupine's* representative saw as far as he remembers it: "The girls were busily at work, the telephonic apparatus attached to their left ears by dainty ribbons, so as to enable them to have their hands perfectly free. The young ladies appeared to my mind to operate with the swiftness and regularity of machines. A lady inspector sits in all her glory in an armchair in the centre of the room, while her assistants walk up and down before the operating boards to see that perfect discipline and silence are maintained and that no private messages are sent by any member of the staff." The "dainty ribbons" is hardly a masculine touch; to the ordinary man the affair seems frankly hideous, but we shall continue to assume that the representative of the *Porcupine* belonged to the masculine sex. He was told that "each young lady has 66 subscribers to attend to, and

sometimes as many as 70, and that it took three weeks for a neophyte to learn her duties," but he thinks it would take as many months before she became thoroughly expert. He was much interested in the battery-room. Next, he says, "I went into an oblong office where, by an ingenious contrivance which I cannot profess to describe, every wire in the service can be tested. So wonderful is this process that by it any break or defect in the wires can be instantly localised, whether in the switchroom or outside, just by touching a certain spot." Only to think of it! Then he was taken upstairs and shown the cables. "A curious circumstance in connection with these cables is the fact that rats run along them. Even the cables that are slimmest in diameter prove no obstacle to the progress of the nimble rodent." (The rats go outside, not inside, like the current.) But "200ft. below them lies the street, and did they fall from their narrow and slippery bridge inevitably would they be dashed to pieces." The rats "are attracted by the pig-skin hooks from which the cables are suspended; in fact, to such a pitch had the depredations of these creatures risen that the telephone authorities were obliged to protect their hooks by a kind of circular saw." For some time past, it is satisfactory to know, the rats have entirely disappeared.

Institution of Electrical Engineers.—A small party of students of the Institution of Electrical Engineers has recently returned from a 10 days' tour in Switzerland, where they visited a number of places of interest. The party left London on the evening of Saturday, August 29, by the Hook of Holland route, and arrived at Bâle on the following evening. On the morning of the 31st the Bâle electric tramway was inspected, and in the afternoon the students went on to Neuhausen, where they saw the Falls of the Rhine. The next morning the party saw the wire-rope and electric power transmissions at Schaffhausen, and in the afternoon were shown over Sulzer Bros.' large engine works at Winterthur, where Mr. Sulzer himself very kindly welcomed the party. The next two days were spent at Zürich, where the central station and two electric tramway stations were inspected. Very interesting visits were also made to the works of Messrs. Brown, Boveri, and Co., the Maschinenfabrik Oerlikon, and Escher, Wyss, and Co. The students were also shown over the physical department of the Zürich Polytechnic, and saw the installation at the Tonhalle, where a battery of accumulators is charged during the daytime off the alternating supply mains by means of a motor-generator, and is used for lighting the concert hall by night. A Pollak rectifier was formerly used for this work, but was found to spark too much. The Dolder cable railway, worked by an electric motor run off a private lighting plant, was also visited. The next day (Friday) the party went on to Lucerne, and had an enjoyable steamboat trip on the lake. The Stanserhorn cable mountain railway, which is driven by electric motors, the electric power being transmitted from a water-power station near the foot, was ascended. Fortunately the day was very clear, and a splendid view was obtained from the top. On the Saturday the students proceeded to Geneva, stopping for a short time at Berne on the way, where the Mekarski compressed-air tramway was inspected. At Geneva three days were spent visiting the National Exhibition, the works of the Compagnie de l'Industrie Electrique (système Thury), the Mont Salève electric rack railway, and the electric light stations, including the new water-power two-phase station at Chèvres, on the Rhone, where 18,000 h.p. is eventually to be utilised. On Wednesday, September 9, the party left Geneva and went to Lausanne by the lake, and the next morning most of the party left Bâle for England after a most interesting and enjoyable trip. The letters of introduction from Dr. du Riche Preller, Mr. Steiger, Mr. Escher (the Swiss representative of the Zurich Incandescent Lamp Company), and the secretary of the Institution, with which the students were kindly furnished, enabled them to see a good deal in the short period to which their visit was limited, and they met with the greatest kindness and attention from the various engineers and others to whom those introductions were addressed.

Foreign Code Telegrams.—Under the regulations of the International Telegraph Convention, code words must not exceed 10 letters in length, and must be taken from one or more of eight languages admitted for the purpose. Moreover, from reasons comprehensible to all electricians, it is desirable that the words used in a code should be so selected that the alteration of a letter or two should not transform any given word into another with a totally different meaning. As some codes are very voluminous, it was difficult to obtain within the restriction of the regulations a sufficient number of selected words; hence words were adopted which were the occasion of disputes between the telegraph administrations and the public as to whether a given assemblage of letters was a legitimate "word" or not. It was therefore decided at the Telegraph Conference of 1890 (at Paris) that the International Bureau of the Telegraph Administrations at Berne should prepare and publish an official list, from which code words could be selected. This "Authorised Vocabulary," consisting of over 260,000 words, was issued at the end of 1895, and purported to be a collection of code words suitable for telegraphic purposes with all dangerously similar words eliminated. It proved, however, to be nothing of the sort, as it was found that a very large number of words were retained which might by very slight alteration be transformed into other words which were also to be found in the vocabulary. It is by Great Britain and its Colonies and dependencies that by far the greatest use of code telegrams is made, and consequently both the Post Office and the Director-General of Indian Telegraphs, as well as the representatives of the submarine telegraph companies, opposed at the Budapest conference of June last the compulsory use of the official vocabulary, and as a result it was decided that the authorised list of words should be added to; that certain proper names should be permitted to be used in a code sense; and that it should be a list, as far as possible, of all the available words in the Dutch, English, French, German, Italian, Portuguese, Spanish, and Latin languages, without any attempt to eliminate words unsuitable from telegraphic or other points of view. Code compilers will thus be left to make their own selection from the Berne vocabulary, as they have hitherto been expected to do from standard dictionaries. This is really the only sensible course to take short of leaving the public to hand in anything for transmission at their own risk. Even an International Board cannot know everything and provide for all needs, and therefore it is better to let the manufacture of codes remain a question of supply and demand. Moreover, existing codes represent a valuable property which should not be destroyed, and therefore the International Bureau asks chambers of commerce, compilers of codes, and all who desire to have the words of their codes inserted in the second edition of the vocabulary, to forward, before the end of the present year, one copy of their code to Berne. In the meantime the decision of the Paris conference of 1890, that the official vocabulary should be made compulsory for Europe from January 1, 1897, is rescinded, and when the conference meets in London, probably in 1901, it will decide at what date the use of the amended official vocabulary is to become compulsory.

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Scientific Education.—The current of controversy in the *Times* on scientific education has been split into two branches—"Scientific Education in England and Germany," "Science in the Old Universities"—but as these both relate to the same thing, and the letters are mostly the work of the same people, we shall treat them as one. Mere induced effects produced elsewhere as a result of the main stream in the *Times* we must, in general, ignore. First, then, we have Sir James Kitson again, who expresses polite incredulity in Dr. Clifford Allbutt's pretty little tales. Sir James says that the assertion that there is "no career in chemistry" in this country is misleading; indeed, absolutely incorrect. His examples, however, relate to iron and steel, not to dye work, organic chemistry, electrolytic processes, or, indeed, nine-tenths of what one first thinks of in connection with applied chemistry. Dr. Clifford Allbutt replies and sticks to the authenticity of his tales. But he gives away his whole case when he adds, "those applications of science which we are discussing at present are but means to the end of so subduing the ruder powers of nature that men may be more free to converse with the ideas of ethics, philosophy, and great literature." First of all, it was, "We do teach it"; now, "We are employed in higher work." As no one found any fault with what Cambridge provided in the way of science teaching, Dr. Clifford Allbutt had better have let the subject alone. The great "Y"—still the only man worthy of large type—insists, in opposition to Sir Bernhard Samuelson, that what is done under "the Technical Instruction Act and the Customs and Excise Act grants" is not enough, and, moreover, is not the right thing. The latter is so true that the former proposition need not be considered here. Further, as against Dr. Clifford Allbutt, "Y" again presses home the question, "Can he say that natural science 'pays' at the older universities?" Till this is on a fair footing with other learning, "a distinct bribe is held out to all the rising talent of the day to follow another groove of intellectual training, and that groove, under present conditions, a somewhat narrow one, notwithstanding the fact that many great minds have been trained in it." Which is true in fact, but how far it is material to the issue may be disputed. "Chemical Manufacturer" again repeats that it is all the fault of the public. "Abroad, good chemists were available before chemical manufacturers wanted them." So apparently they tried them and found them useful. The argument is probably better than it looks. Sir Bernhard Samuelson defends the spending of the available money on popular and elementary scientific teaching on the ground that "the rating power under these (the Technical Education) Acts will be a dead letter till the ratepayers themselves have been educated to understand what higher technical education means, and its pecuniary value to the country." But what is going to happen while a new generation is growing up? Also Sir B. Samuelson says Sir James Kitson is too confident and under-rates the fierceness of the present struggle with other countries, and what it is likely to become in the immediate future. Mr. R. J. Friswell complains that there is only one manufacturing chemist amongst the members of the Royal Society, and he ceased active association with manufacture 23 years back. Surely this is a matter which has as little real influence on the question as the fact that was made so much of, that in Court and "noble" circles in Germany there is more readiness to be civil and polite to a scientific professor, who is quite harmless, than to a rich manufacturer, who might, if he were encouraged, become a serious rival in the social sphere.

Maidstone Technical School.—We have received the prospectus of the winter classes at the Maidstone Municipal Technical School. There are elementary and advanced classes in magnetism and electricity, and a class in practical electricity which is to cover such matters as the construction and calibration of electrical measuring instruments, switchboards, and regulating apparatus, the principles of electric light fitting, joint making, how to design an electric light installation, telegraphy and telephony, construction of instruments, testing for faults in lines and cables, etc. The electric installation at the school is available for the purpose of instruction. These three classes are under the care of Mr. W. A. Stevens, A.M.I.C.E. To celebrate the opening of the winter session there has been a conversazione at the school. According to the programme, there was a concert, but the local newspaper ignores that, presumably as below the dignity of technical education, and remarks that the proceedings "were for the greater part of a scientific character. They were well calculated to create an inkling after knowledge." After this, in the first half-dozen lines it might be imagined that the reporter would have some difficulty in keeping up to the same standard all through. Nevertheless, he manages it by devoting the whole of the rest of his account of the conversazione to a lecture by Mr. Stevens on the Röntgen radiations. Yet though the result is that Mr. Stevens's contribution to the conversazione gets 91 per cent. of the available space, that gentleman is not satisfied, and is believed when he read his lecture in print to have cast about and considered the proper way of blowing up the editor, reporter, and literary staff of our Maidstone contemporary. It is greatly to be regretted that, according to the reporter, Mr. Stevens "was unable to give a thoroughly practical demonstration with the 'X' rays, as he had not a sufficiently powerful induction coil at his disposal to produce so great a number of vibrations per second as was required. His instrument would only produce a spark 6in. long, whereas the operation required a spark 3ft. in extent." We cannot think that the managers are seriously to blame in not providing any means of procuring yard-long sparks, although it would have been certainly more exciting. Some people are never satisfied. The following are a few other gems selected from this report of what Mr. Stevens did not say: "In explaining the sources of light, Mr. Stevens said that the air we breathe is like a mass of jelly, and light was known to exist by a sharp luminous object on which the rays fall, then the ether vibrations are presented by the object on which the light falls; they take up the vibration of ether and then the light or reflection from them enters the eye, in which, by way of the nerves, the brain receives the sensation of light." What could be simpler? We are sorry to hear, however, that even a portion of the Maidstone air is as thick as jelly, although the inhabitants apparently select that portion for breathing—perhaps under the idea that it is nourishing. "The lecturer went on to explain the difference between the conception of the ear and eye. The eye, he said, was only capable of realising light to the extent of from 16,000 to 30,000 vibrations, while the ear had an extent of from 39,000 to 50,000 vibrations." And, finally, "the only reason why we could not see through a brick wall was because of the rays of vibration." But seriously, if even the most junior reporter doing his honest best and with his shorthand to help him makes such a glorious mess of it when he tackles an unfamiliar subject, what sort of notions must many of the general public get from a popular science lecture? Fortunately they never try to apply their misinformation.

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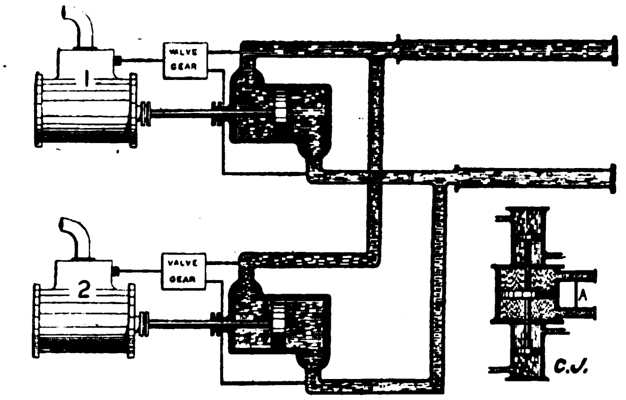
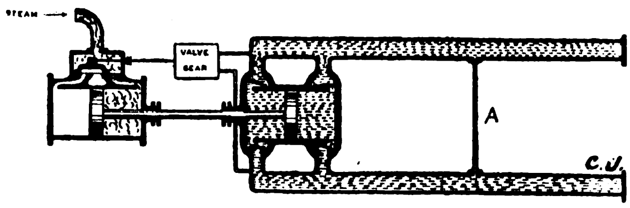
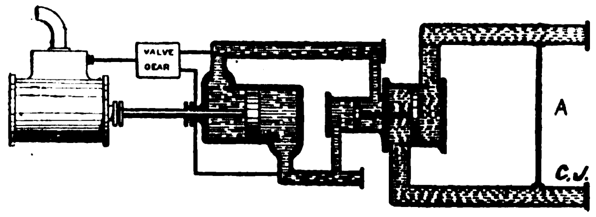
THE BRISTOL CENTRAL ELECTRIC LIGHTING STATION.*

BY J. R. BLAIKIE, ASSISTANT ELECTRICAL ENGINEER TO THE CORPORATION OF BRISTOL.

In the following description of the Bristol central lighting station the author proposes to deal solely with the principles as compared with other electric lighting stations, drawing attention to characteristic features of the present plant. There are in existence now about four types of lighting systems — viz., low-tension continuous; high-tension continuous; high-tension alternating; high-tension alternating polyphase. Combinations of two or more of these systems are frequently used, but one is usually sufficiently developed to characterise the station. Bristol belongs essentially to the high-tension alternating class. Before going further, it would perhaps be interesting to point out the *raison d'être* of these various systems. Hydraulic analogies will be correct enough for this purpose, and are extremely simple to follow.







Case I.—Low-tension continuous: The usual requirements of this system are, first, that there shall be a constant pressure maintained on the supply mains, and, second, that the speed of the machine shall be constant, as there would be a difficulty with the prime movers if this were not the case. In considering a pump, therefore, the pressure of the water must be kept to a standard, and the number of strokes per minute constant. The quantity of water delivered may vary; this can be met by varying the length of the stroke to suit the delivery demanded. In the diagram is shown a box containing such mechanism as will operate on the steam-valve to fulfil these conditions. The small pipe, A, connecting the mains represents a lamp. When such a flow as the area of the pipe will permit under the constant pressure passes the analogy is complete, and in the case of a lamp and an electric current the filament would be heated to a high temperature and emit light. It is obvious that by connecting in more small pipes between the mains the resistance to the flow is reduced and a larger quantity of water will pass. This necessitates a longer stroke of the pump, and consequently more work is done (the same pressure on the plunger acting through a greater distance.) In this case we can also store the energy by means of an accumulator, and the analogy still hold good. In order to serve all consumers alike, it is necessary to maintain this constant even pressure over all the supply mains. There is a difficulty in doing this; owing to the resistance the mains themselves offer to the flow the pressure would diminish a little at the more remote parts of the circuit. This difficulty can be obviated by having extra large mains; but these are very expensive. There is another way of satisfying the conditions, which is known as the high-tension system (Case II.). We now make our pump supply water at a pressure which is, say, 10 times too great for the lamp. This high-pressure water is taken to sub-stations and is used to drive water motors, which in their turn operate pumps designed to supply 10 times the quantity of water at one-tenth of the original pressure. These sub-stations can be placed at convenient points for secondary distribution. The high-tension or primary mains will therefore only have to carry a small quantity of water, and may be large enough to carry it for long distances without much loss of pressure. This completes Case II. It will be observed that all that is necessary to illustrate a lighted lamp is a small pipe with a flow of water through it. It does not matter which way the current flows, or even if it flows alternately in opposite directions, provided that the alternations or reversals are sufficiently rapid. The analogous hydraulic mechanism for the production of alternating flows simply consists of a pump without any valves, and a transformer, two cylinders of relative areas with pistons attached to a common piston rod. This is Case III., the high-tension alternating. In the diagram the high-pressure water is represented by long thin lines, and the low-tension by short thick strokes. The advantage of this simplicity is readily seen. There are disadvantages, however, which prevent it becoming universal. The energy cannot be stored, and it is not so well adapted for driving rotary motors which may be required for the supply of power to workshops. This system is consequently restricted to the supply over large areas (which necessitates high tension), and where the demand is likely to be for lighting only. A bold development of the high-tension alternating system is the fourth case, known as the polyphase or two-phase. Its object is to overcome the disadvantages of the former type with regard to motors. But this is beyond Bristol, or even the whole of the English practice at present, so it is unnecessary for the author to go into any further description. Before leaving hydraulic analogies, there are one or two requirements of an alternating station that can be aptly illustrated. When the quantity demanded is such that the pump has reached its full stroke, or full capacity, it becomes necessary to connect on one or several more to help it. On referring to the diagram it is clear that it would not do, with pumps having no valves, for one pump to be on the suction stroke when the other is delivering, while both are connected to the same main. If this were the case the water would simply flow between the two pumps, and not through the circuit of mains. Both pumps must deliver at exactly the same moment, or, in other words, run synchronously. Of course the two pumps may be running with different lengths of stroke, delivering different quantities, but the periods of delivery or suction must coincide. When once in phase or in step they tend to remain so, as the lagging pump will be driven by the leading one until it makes up the speed again. The flow passing between the two pumps to keep them in phase is called the synchronising current, and is obviously waste energy. It is therefore of the utmost importance that the motive power supplied to the pumps should be controlled in such a manner as to keep them in step with the smallest possible synchronising current. The method of ascertaining the condition of phase in two machines, running independently before they are connected, and finding the precise moment to make the connection, is very simple. Two transformers are connected as shown in the diagram. The high-pressure cylinder or primary of one is connected to the one pump, and the high-pressure cylinder of the other transformer to the other pump, in such a way that if the impulses from each pump tend to make the two high-pressure pistons approach or recede from each other, there will be no flow in the pipe, A. If, on the other hand, one piston recedes as the other approaches, there will be a flow

* Paper read before the Association of Municipal and County Engineers at Bristol.

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in A. A, as before, represents a lamp, and as the lamp glows or remains dull the phase is discovered, and the connection is made just at the moment when it glows brightly. One step further reaches a characteristic of the Bristol station. There are, broadly speaking, two kinds of alternators. The one in use here is represented by a pump as shown, having rigid walls. This type is known by the feature of low self-induction. The other type, having high self-induction, could be represented by a pump having elastic walls. In the latter case (with elastic walls) a sudden flow from one to the other would tend to stretch the walls, and the piston of the lagging pump would not respond so quickly to the urging influence of the other. This is an advantage in some respects, as it prevents undue strains in the machines if they should get out of phase. On the other hand, it encourages an alternating interchange of current between the two machines, which may grow into a dangerous swing and so throw them out of step. It is therefore desirable that the pumps should have this expansive property just at the time when they are connected, and made rigid again when properly in phase. This is done in Bristol by means of choking coils. The equivalent in the pumps would be by making communication with two elastic bladders at either end of the cylinders, for the more or less uncertain time of making the connection, and cutting them off afterwards. With the aid of these preliminary remarks the author hopes to be able to make some of the excellent points in this installation more apparent.

Beginning with the generating plant all machines are direct driven, thus saving considerable space and eliminating the losses in transmission by ropes or belts. Driving direct means using high-speed engines, and we have what is generally accepted as the most satisfactory and efficient of this class—viz., the Willans and Robinson central-valve engine. All are compound and single acting; the high-pressure cylinder is in line with the low-pressure, tandem style. With the dynamos, or continuous-current machines, there are two lines of cylinders acting on two opposite cranks. With the alternators there are three lines, acting on three cranks at 120deg. Now we have seen the necessity of keeping the alternators in phase. That not only means keeping the speed of two or more engines exactly the same, but also each part of a revolution in various machines must be synchronous. The three-crank Willans engine is unique in conforming exactly with the required conditions. The three cranks at 120deg. keep the angular velocity constant, and further, owing to the tandem arrangement of the cylinders, the work done on each crank is the same, no matter what proportion of it is done by the high or low pressure cylinder. The engine is thus enabled to give a perfectly even turning moment when running at light load, which is most important for the process of synchronising. With other types of engine the angular velocity can be kept constant by using heavy flywheels, but these, of course, absorb power in themselves. Another disadvantage to the use of flywheels is that the speed of the incoming engine cannot be varied so rapidly to synchronise with the present running plant. There are several interesting features in the Willans engine that claim attention. The cranks run in a bath of castor-oil and water, which not only makes a very efficient means of lubrication, but is suitable for indefinite runs : a week or more, night and day, is no difficulty whatever. There are tubes provided in the bath for cooling purposes, and cold water may be circulated if necessary. The engine being single acting, all the bearings are in constant thrust, so the wear takes itself up automatically, and thus prevents knocking. For thermal principles and safety there is practically no cushioning in the cylinders; the momentum of the reciprocating parts is balanced by an air buffer on the up stroke; on the down-stroke some energy is taken from the flywheel, which is necessary in order to keep the connecting-rod bearings tight on the cranks. In engines as at Bristol, suitable for condensing, the exhaust steam from the low-pressure cylinder is transferred on the up-stroke to the under side of the piston, and opened to the vacuum on the next down-stroke, so that all work is done on the down-stroke, the essential principle of the engine. Particulars as to the number and capacity of the alternators will be found in the schedule annexed. The other generating plant consists of four dynamos (represented by pumps with valves), which supply a continuous current or flow. Two of these supply current for inducing the magnetic field in the alternators, and are called "exciters"; the other two "arc machines" supply the current for the street illumination by means of arc lamps. The principal reason that continuous current is preferred for arc lighting is because an arc formed between two carbon pencils with continuous current can be made to burn the top carbon in the form of a crater, and the lower one to a point. This formation reflects the light downwards, and so illuminates the more useful area. Steam is supplied at 125lb. pressure per square inch from a ring main, having valves inserted at suitable distances so that one portion may be cut out for repairs without interrupting the supply. The ring is fed by seven steel Lancashire boilers, which are arranged in two batteries of three and four on either side of the chimney. The chimney is 180ft. high, 9ft. 6in. internal diameter at the bottom. It is built in two shells, having a ventilating space in between. The boilers are fired by mechanical stokers of the coking type, made by Messrs. Vicars and Co. The coal is pushed on to the front of the fire, which causes the unburnt gases to pass over red-hot cinders and so ignite. With Welsh steam coal and this system of firing there is no smoke whatever. The coal is raised from the bunkers by means of an elevator and carried to the hoppers of each boiler by a conveyer, consequently there is no handling of the fuel to be done at all. The firemen have simply to regulate the mechanism, attend to the feed-water, and remove the ashes and clinker every few hours. After the steam has passed through the engines it is led away to the exhaust-main (which is also in a ring form with valves, as in the steam-ring). The exhaust-main has three outlets—one to the condensing plant, one to the atmosphere, controlled by a wheel valve, and the third to the atmosphere, controlled by an automatic back-pressure valve. In the normal condition of working the steam is condensed, and a vacuum of 25in. easily maintained. The condensing plant consists of one evaporator, to make up the water lost by small leakages; one large surface condenser; two centrifugal pumps, for circulating cold water from the river; and two air-pumps, for drawing off the condensed water. One pump of each sort is sufficient to do all the work at present; the others are spare plant.

Having dealt generally with the whole of the generating plant, we now come to the control and distribution of the electric current. The mains from all machines are brought up to the switchboard. Each machine has a separate panel, on which is mounted the necessary measuring instruments, switch, and safety fuses. From the board at the present time run 15 feeders to various parts of the city, some of them over two miles in length. Each feeder has its own instruments, etc., mounted on a separate panel. The arc-board is similarly provided with machine and circuit panels. The sub-stations are mostly under the pavements, and are brick-built chambers, 10ft. long, 6ft. wide, and 6ft. deep internally. They are spaced out to meet the requirements of each district, and are generally about 500 yards apart. The distributing cables run from sub-station to sub-station, thus making a network. The actual transformers are even simpler than the hydraulic model, for they have no moving part whatever. They consist of two coils of insulated wire wound on a laminated iron core. The ratio of the two pressures is proportional to the relative number of convolutions in each coil. As a matter of fact, by an arrangement known as the three-wire system, we are enabled to use double the pressure required for an ordinary lamp, and thus save considerably in the size of the mains. The cables are all lead-sheathed and armoured; they are laid in the ground in about 150-yard lengths, and beyond a covering of loose bricks require no further protection. It does sometimes happen that the "sanitary authority" in their enthusiasm for wood paving drive a steel drift clean through a cable, but in such cases it is questionable as to whether anything less than a 6in. armour plate would offer sufficient resistance. All the current is supplied by meter, and when consumed between the hours of 12 midnight and an hour before sundown it is supplied at a cheaper rate. This is contrived by means of a clock, which automatically

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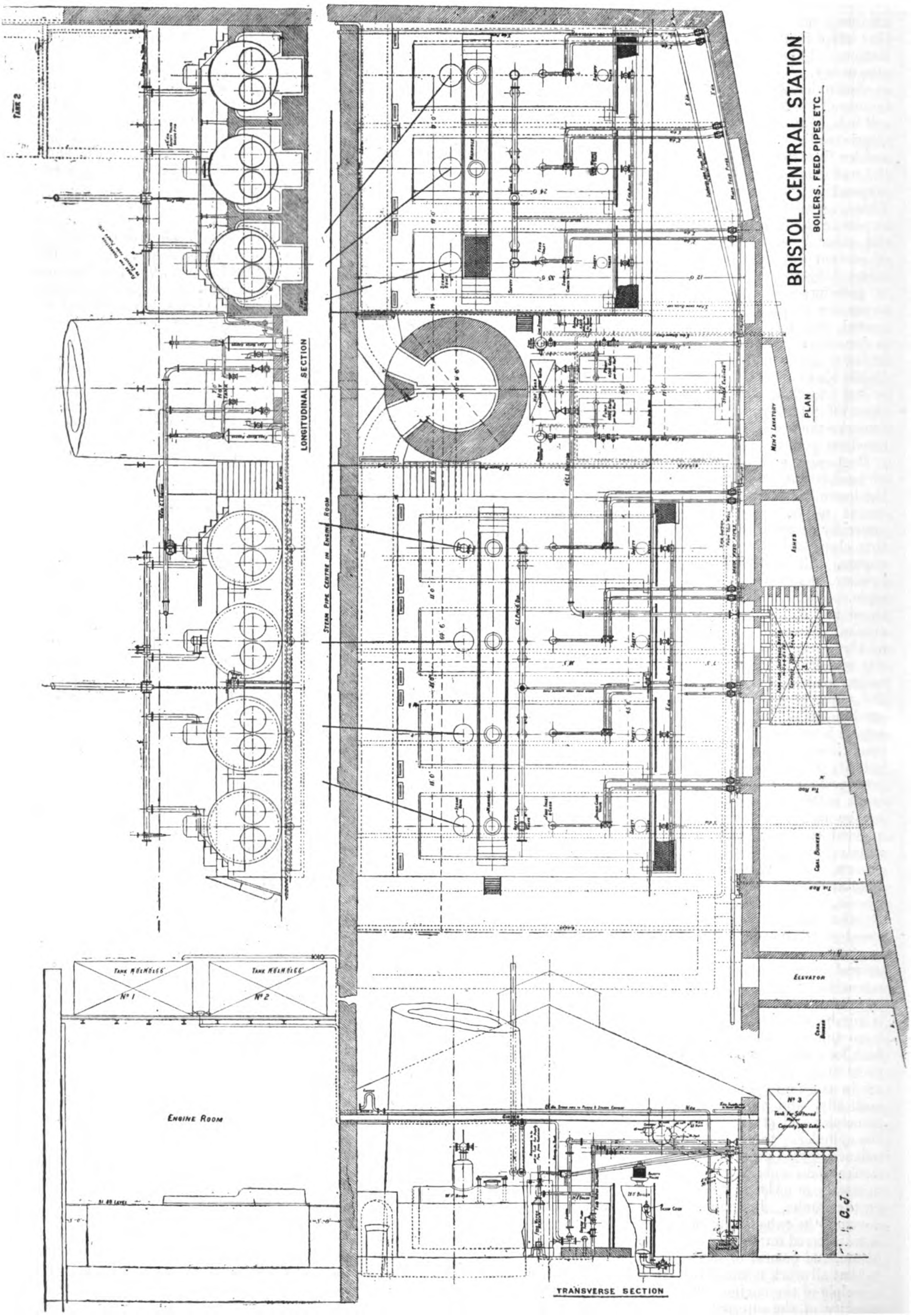
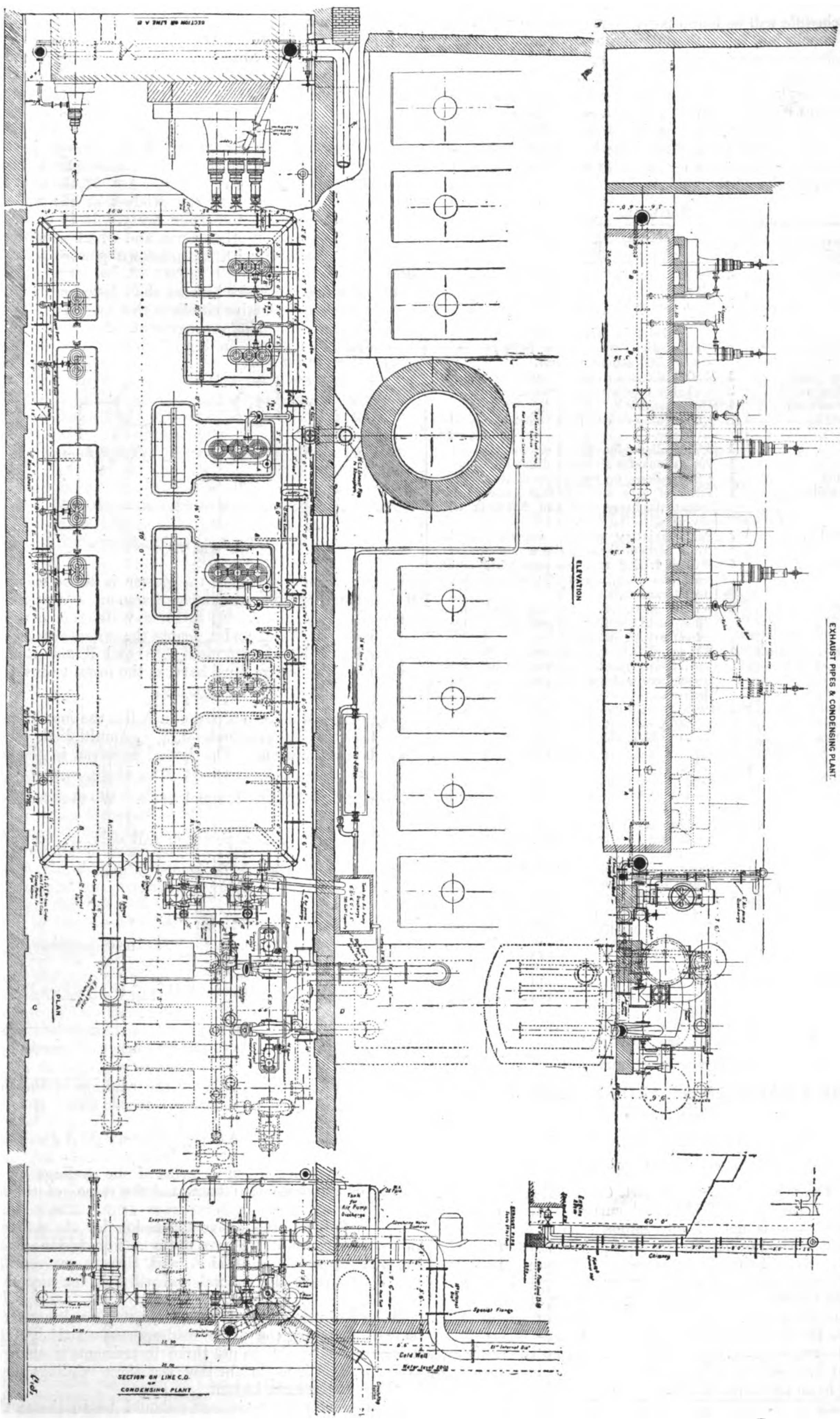

BRISTOL CENTRAL STATION
BOILERS, FEED PIPES ETC.
PLAN
LONGITUDINAL SECTION
STEAM PIPE CENTRE IN ENGINE ROOM
TRANSVERSE SECTION
ENGINE ROOM
TANK 2
MEN'S LAVATORY
ASHES
COAL BUNKER
ELEVATOR



BRISTOL ELECTRIC LIGHTING.
EXHAUST PIPES & CONDENSING PLANT.

opens a small by-pass to the meter during these hours. In the schedule will be found particulars of all the plant.

In conclusion, the author desires to say that the aim of the foregoing paper is to make the subsequent visit to the works more interesting. With this object perhaps it is unnecessary to apologise for ignoring the well-beaten track of the cost of electric supply. With regard to the success of the undertaking, however, it will be sufficient to state that the Electrical Committee intend carrying out extensions during the next two years that will about double the present capacity of the station.

SCHEDULE.

Plant.	No.	Remarks.
Boilers	4	Steel Lancashire, with cross tubes, 28ft. by 8ft.
Boilers	3	Steel Lancashire, with cross tubes, 24ft. by 8ft.
Stoker engines	2	Vertical simple, driving stokers, &c.
Feed-pumps	2	Duplex direct-thrust type, built by Owen, each 4,000 gallons an hour.
Donkey pump	1	2,500 gallons per hour (type as before).
Feed heaters	2	Kirkaldy type with live steam.
Water softener	1	Howatson's.
Tanks	2	7,000 gallons each, in connection with softener.
Tank	1	3,760 gallons, for storing softened water.
Tank	1	790 gallons, for air-pump discharge.
Hot-tank	1	1,200 gallons, for feed-pump suction.
Oil-feed filter	1	Filter of coke and shavings between air-pump discharge tank and hot-tank with by-pass.
Cold-well	1	For circulating pumps, suction supplied from harbour through sluice-valve.
Engines	4	Willans I.I.I.S. type, compound, three-line, each 360 i.h.p., speed 350, coupled direct to alternators.
Engines	2	Willans G.G.G.S. type, compound, three-line, each 150 i.h.p., speed 465, coupled direct to alternators.
Engines	4	Willans G.G.S. type, compound, two-line, each i.h.p., speed 465, two coupled direct to exciters and two coupled direct to arc-lighters.
Evaporator	1	Capacity with live steam half ton per hour.
Condenser	1	30,000lb. exhaust steam per hour.
Air-pumps	2	Capacity 250 cubic feet per hour.
Circulating pumps	2	Capacity 2,800 gallons per minute through 15ft.
Alternators	4	Siemens 210-kilowatt 7,000 8-c.p. lamps, each coupled direct to Willans I.I.I.S. engines.
Alternators	2	Siemens 88-kilowatt 2,900 8-c.p. lamps, each coupled direct to Willans G.G.G.S. engines.
Exciters	2	Siemens 100-volt 50-kilowatt, coupled direct to Willans G.G.S. engines.
Arc-light dynamos	2	Siemens 100-volt 50-kilowatt, coupled direct to Willans G.G.S. engines.
Battery	1	A small storage battery of 54 cells in a room on the station is used for exciting the alternators on occasion, and for some of the station lights.
Switchboards	2	One consisting of six machine panels and 16 feeder panels, also synchronising panel; the other consists of two arc machine panels and eight arc circuit panels, also one exciting circuit panel.

THE PRINCIPLES OF ALTERNATE-CURRENT WORKING.*

BY ALFRED HAY, B.Sc.(EDIN.), A.I.E.E.

(Continued from page 343.)

67. The result deduced in Art. 61 for the power in a circuit in which both E.M.F. and current obey the simple harmonic law is not of any importance as furnishing a practical method of measuring the power in an inductive circuit. Even if the simple harmonic law were followed in a given case, we should have to know the angle of lag, and the best method of determining this would, in fact, be to measure the power. The power measurement would thus precede the measurement of the angle of lag. The student must therefore guard against the fallacy that the result of Art. 61 furnishes us with a *practical* method of measuring power in an inductive circuit.

* Based on a series of evening lectures delivered at the University College, Liverpool.

Any method of measuring power which is to be of use in practice must be applicable to E.M.F.'s and currents of any shape whatever. In the next few articles we shall give an account of two of the most important methods of determining the power in an inductive circuit. A large number of methods have been invented from time to time, but by a process of selection only a few of these have survived to the present day.

68. When the circuit in which the power is to be measured is a non-inductive one the measurement presents no difficulty. For, as was shown in Art. 58, the true watts are in that case equal to the product of the volts and amperes, the power factor being unity. It is only where we have inductance in the circuit, and where consequently we have to reckon with an unknown power factor, that difficulties occur.

69. The first method which we shall describe for measuring power in an inductive circuit is that known as the *three-voltmeter* method. The arrangement of connections for this method is shown in Fig. 53, where A B denotes the

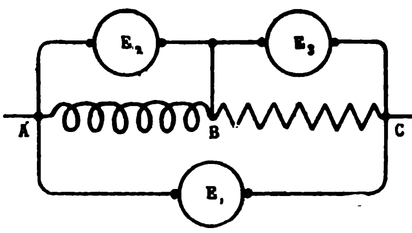


FIG. 53.

inductive circuit in which the power is to be measured, B C a non-inductive resistance of amount r connected in series with A B, and E_1, E_2, E_3 three voltmeters connected as shown. Let v_1, v_2, and v_3 denote the *instantaneous* values of the P.D.'s between A and C, A and B, and B and C respectively. Then we must have, at the instant considered,

$$v_1 = v_2 + v_3 \quad . \quad . \quad . \quad . \quad . \quad (a)$$

Next, the instantaneous power in A B is the instantaneous P.D. between its terminals—*i.e.*, v_2—multiplied by the instantaneous current. The latter, however, is the same as the instantaneous current in B C, which, since B C is a *non-inductive* resistance, is equal to $\frac{v_3}{r}$. We thus have

$$\text{instantaneous power in A B} = \frac{v_2 \cdot v_3}{r}.$$

But from the equation (a) above we find

$$v_1^2 = v_2^2 + 2\, v_2 v_3 + v_3^2,$$

whence $$v_2 v_3 = \tfrac{1}{2}\,(v_1^2 - v_2^2 - v_3^2).$$

Substituting this value for $v_2 v_3$ in the expression for the instantaneous power, we get

$$\text{instantaneous power in A B} = \frac{1}{2\,r}(v_1^2 - v_2^2 - v_3^2),$$

and hence

$$\text{mean power in A B} = \frac{1}{2\,r}\;(\text{mean } v_1^2 - \text{mean } v_2^2 - \text{mean } v_3^2).$$

Now if V_1, V_2, and V_3 denote the readings of the three voltmeters, we have $V_1^2 = \text{mean } v_1^2$, etc., so that

$$\text{mean power in A B} = \frac{1}{2\,r}\,(V_1^2 - V_2^2 - V_3^2),$$

so that the power is given in terms of the readings V_1, V_2, and V_3 of the three voltmeters, and the value r of the non-inductive resistance.

70. In deducing the above expression for the power in the inductive circuit, we have made no supposition regarding the shape of the E.M.F. and current waves. The reasoning is perfectly general, and will hold for any shape of wave.

Instead of using three voltmeters, a single voltmeter may be used for taking the three readings consecutively. But it is always advisable to use three instruments if these are available, as it is important that the three readings should be taken at the same instant.

The non-inductive resistance r should be so chosen that the reading V_3 is as nearly as possible equal to V_2.

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On the whole, the three-voltmeter method of measuring power cannot be considered a thoroughly satisfactory one. It is in most cases difficult to get good results with it, and sometimes comparatively trifling errors in the readings may give rise to a serious error in the determination of the power. Again, in order to carry out the measurement under the best possible conditions, the resistance r must be made large enough to absorb more power than that which is taken by the inductive load under test. For, as mentioned above, V_2 and V_3 must be made as nearly equal as possible to secure the greatest accuracy, and since the power factor for r is unity, while that for A B is generally less than 1, it follows that r will absorb more power than A B. The introduction of the resistance r, therefore, altogether upsets the existing conditions of the circuit, and in order to restore these we must provide a source of higher E.M.F. (about double that required by A B). It is not always convenient to do this, and hence the three-voltmeter method is necessarily limited in its application.

71. The most generally useful method of measuring power in an inductive circuit is that involving the use of a *wattmeter*. A *wattmeter* is an electrodynamometer provided with two coils—a fixed coil of thick wire and a movable coil of fine wire. The fine-wire coil is connected in series with a large non-inductive resistance, so that the time-constant (Art. 35) of the fine-wire circuit is extremely small, and hence its impedance practically equal to its resistance (Art. 38); the current in the fine-wire circuit will under these conditions be practically in phase with the P.D. across its terminals, the angle of lag being extremely small.

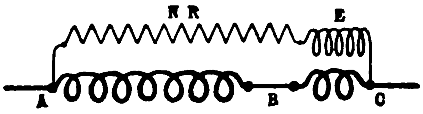

Fig. 54.

In Fig. 54 A B represents the inductive circuit in which the power is to be determined, B C the thick-wire coil of the wattmeter, E the fine-wire coil, connected in series with the non-inductive resistance N R. The couple acting on the fine-wire coil at any instant is proportional to the product of the currents through the two coils at that instant. Now the current through the fine-wire coil is, as stated above, in phase with the P.D. across A C, and is proportional to this P.D. Again, the current through the thick-wire coil B C is the same as the current through A B. Hence the couple acting on the fine-wire coil is proportional, at a given instant, to the instantaneous product of the P.D. across A C into the current through A C, and therefore the reading of the instrument, which depends on the mean value of the couple, will be proportional to the mean power. By multiplying the wattmeter reading by a certain constant, we at once obtain the power in A C.

Since the resistance of the thick-wire coil of the wattmeter is very low, the introduction of it into the circuit does not materially alter the conditions already existing in the circuit; in this respect, the wattmeter method of measuring power has a great advantage over the three-voltmeter one. The amount of power absorbed by the thick-wire coil is, it must be noted, included in the measurement. An allowance may be made for this, if necessary, by subtracting from the total power measured the product of the resistance of the thick-wire coil into the square of the current (which may be measured by an ammeter included in the circuit, outside A C *).

The constant of the wattmeter may be determined by using, in place of A B, a known non-inductive resistance, and measuring the current through it and the P.D. across its terminals. The product of these two quantities will give the power (Art. 58), and if the corresponding reading of the wattmeter be noted the constant of the instrument is at once determined.

* The ammeter might also be placed in the part of the circuit included between A and C; in this case, however, the amount of power absorbed by the ammeter must be added to that taken up by the thick-wire coil of the wattmeter.

72. At one time the wattmeter was not considered a satisfactory instrument. Readings obtained with it were found to be unreliable, and the instrument came to be looked upon with suspicion. The reason of this, however, lay in the faulty construction of the instrument, and a good modern wattmeter furnishes the best method of measuring the power in an inductive circuit. There are, in particular, two important points which should be carefully attended to in constructing a wattmeter. The first is that the time-constant of the instrument should be negligibly small, so that the current in the fine-wire circuit is for all practical purposes in phase with the P.D. at its terminals. The second point is that the supports of the coils, etc., should be constructed entirely of insulating material. If the instrument is provided with a case, the case should also be of insulating material. The presence of any large masses of metal in the neighbourhood of the wattmeter seriously affects its readings, owing to the currents which are induced in these masses by the alternating magnetic field due to the fixed wattmeter coil. These eddy currents react on the wattmeter and alter its reading. The student will understand this action better when we come to deal with electromagnetic repulsion phenomena, which will form the subject of the next few articles.

(To be continued.)

APPLIED ELECTRO-CHEMISTRY.*

BY JAMES SWINBURNE.

LECTURE II.

(Concluded from page 356.)

To sum up, in the electric and magnetic circuits the potential is cyclic. A unit charge or pole allowed to move in obedience to the force acting on it falls in potential continuously, and is not raised in potential at any point. The difference of potential is localised by the properties of the electric circuit itself, such as the resistance and the properties of the dielectric, leaving convection currents out of the question for the moment; and as there is no such thing as magnetic conductivity, the difference of magnetic potential is localised by the permeability and arrangement of the different parts of the magnetic circuit, and not directly by the position of the excitation. The engineer will say, "The lines of induction cut the wire of the electric circuit at certain places, and must generate the E.M.F. at those places, just as in a dynamo the E.M.F. is generated in the wires cutting the strong field. This is shown by the force on the wires there." The answer to this is that lines of induction are a mere conventional idea. Even following the idea up it will be found to be impossible to localise the cutting of the conductors by the lines. We can find two successive distributions, and we may assume that lines move or that a conductor moves past them and has a pressure induced in it. This is mere assumption though. All we can really deal with is the variation of the total induction interlinked with the electric circuit. No conceivable instrument will show where the lines cut the conductor. A voltmeter may be connected in shunt to a part of the conductor and give a reading. That voltmeter has leads to it, and the voltmeter and the leads form a local circuit, and any variation of the total induction through the local circuit gives a voltmeter reading. Carrying a charge on a proof plane and measuring the work done is the same thing. As to the force on the conductors of a dynamo, that depends only on the current. The force even then acts on the conductor carrying the current, not on the current. Similarly, in a magnetic circuit you cannot find any effect due to the location of the excitation.

This may at first seem a long digression from the question of the seat of the E.M.F. in a cell. But let us carry the idea of a cyclic potential to a cell with two terminals, connected by two pieces of wire to, say, a resistance which, in comparison with that of the rest of the circuit, we can consider infinite. Consider a unit quantity of electricity at the positive terminal of the cell. Suppose the cell gives one volt. Call the potential at the positive terminal anything, say 100. Follow the charge along the resistant part of the circuit. It does work and falls one volt, and gets to the negative terminal. The negative terminal is, therefore, at 99 volts. Seekers after the seat of the E.M.F. seem to assume that if the charge goes on through the cell to the positive terminal, the potential there will be 100 again; but it will only be 99. The potential of the terminals differs by a volt if considered as connected by the resistance, but they are at the same potential considered as connected through the cell. If the charge were raised one volt on its way through the

* Cantor lectures delivered before the Society of Arts.

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cell, the line integral of the electric force round the circuit would be zero, and the cell could do no external work.

A great deal of work has been done on contact differences of potential and allied subjects, but there is room for a fallacy. The difference of potential between A and B is defined as proportional to the work done by a unit charge of electricity going from A to B, but one cannot work with charges of electricity without something to carry them; and if A and B are conductors which may act chemically on the carrier, or on films of moisture or gases surrounding it, we are not really simply finding the difference of potential of A and B.

If the chemical pressure of the cell is higher or lower than the actual, so that the cell heats or cools on discharging, it might be said there must be something corresponding to glorified Peltier, Seebeck, or Thomson effects (it is difficult to remember which of these effects is which) between the metals and its electrolyte, and between the electrolytes, if there are two. But the algebraic sum of these differences taken through the cell must be zero, so the generation of heat, or its disappearance as a whole, must be regarded as chemical, or in some other way. Some day the theory of ions may be worked out on circuital principles. In the meantime I will go back to the usual way of discussing dissociation.

Dissociation.

Not so very long ago it was supposed that in aqueous solutions the water conducted the electricity, oxygen and hydrogen being given off in the nascent state. The nascent gases were then supposed to react on the substances in solution, oxidising and reducing them. Recently, however, as already mentioned, the theory of solutions and of electrolysis has made enormous strides, especially in Germany. The names of Hittorf, Ostwald, Arrhenius, van t'Hoff, and especially of Nernst, are more particularly identified with this development.

Too much space has been already given to the theory, or, rather, to one or two details of theory, to leave room for a long account of recent ideas of electrolytic dissociation. The theory is, that when a body is dissolved in a solvent, its molecules are moving as they would be in a gas. The mean free path of the molecules must, of course, be enormously smaller in a solution, and, I believe, that has been put forward somewhere as an objection to van t'Hoff's theory. Under certain assumptions, however, the figures work out right. If a small quantity of sugar, say, is dissolved in water, and the solution is separated from pure water by a diaphragm through which the sugar cannot be diffused, water will diffuse into the sugar side of the vessel. If it is closed water will come in, until a certain pressure is produced. This is the osmotic pressure, and it is found to depend on the number of molecules of sugar per cubic centimetre of liquid. Solutions with the same number of gramme equivalents per litre of different non-electrolytes give the same osmotic pressure, and the pressure corresponds to the pressure they would give as gases occupying the volume of the whole solution. Solutions containing the same number of gramme equivalents per litre also give the same vapour tension, and the same freezing point. Electrolytes, however, have higher osmotic pressures than Avogadro's law applied to solutions would give. This is explained by the dissociation or ionisation of salts in solution. Dissociation is a rather unfortunate term, as it is used for such splitting-up as that of ammonium chloride into ammonia and hydrochloric acid when heated, in which cases both the bodies found are ordinary substances. In electrolytic dissociation, for instance, salt splits into sodium and chlorine. The chlorine and sodium atoms are not as in free chlorine and metallic sodium, but are electrically charged, and give up their charges to the anode and cathode. Only part of the salt is dissociated, the proportion not dissociated or ionised depending on the strength of the solution. Thus, in a very strong solution very little of the salt is ionised. The term "ionised" is perhaps preferable to dissociated, as it suggests electrolytic dissociation as opposed to ordinary dissociation where the compound is not split into electro-negative and electro-positive radicles. As the solution is more and more diluted, the salt becomes more and more ionised. The electrical conductivity is due to the possibility of convection currents of the ions. The salt that is not ionised does not conduct. The current in the liquid consists of charged ions moving in different directions under the electric force. As the ions come against the electrodes they give up their charges, and are deposited as metals or given off as gas, as the case may be. The conductivity of a solution depends only on the number of free ions per cubic centimetre. A very strong solution has very few, so it conducts badly. As the solution is diluted the ionisation goes on more quickly than the dilution, so that though there is less of the elements of the compound in a cubic centimetre, the proportion ionised is so much greater that the total number of free ions per cubic centimetre is increased, and with it the conductivity. As dilution proceeds the ionisation no longer compensates for its effect, and we finally have a very dilute solution in which, though the ionisation is nearly complete, there are so few ions in a given volume that the liquid hardly conducts. Suppose, however, however, that we take a given quantity of the salt and dissolve it in a right prism of water of a given length with electrodes at the ends, and measure, not the conductivity, but the conductance from plate to plate; as the liquid is diluted the increase of cross-sectional area of the prism exactly counteracts the decrease of conductivity due to there being less of the elements per cubic centimetre, so that the increased ionisation tells independently. By this method, in fact, the combined charge-carrying capacity of all the free ions in a given quantity of salt is measured, and it increases with dilution as the ionisation goes on and tends towards a maximum at the point of complete ionisation, which exists at infinite dilution. By making a series of observations the molecular conductivity at infinite dilution—that is, under the condition of complete ionisation—is found, and the ionisation or the proportion of the ionised part to the whole of the salt at any dilution can be found from the conductivity. The results so obtained account perfectly for the osmotic pressure of an electrolyte being greater than that of a colloid or non-electrolyte. After ionisation the separate ions act as molecules, so that a dissolved electrolyte behaves as if there were an extra number of molecules added, corresponding to the ionisation. Electrolytes also lower the freezing points of solutions, and raise their boiling points more than corresponding gramme equivalents of non-electrolytes, but the results are quantitatively right when ionisation is taken into account.

The current in an electrolyte consists of a convection transfer of charges due to the ions moving in different directions under the electric force. They move at different rates under a given electric force. This is a point of some importance in practical work, as it controls the concentration of the solution in the immediate neighbourhood of the cathode and anode. The movement or migration of the ions must not be confounded with electric osmosis, which is a different phenomenon. Suppose we electrolyse a solution of hydrochloric acid. This consists of water, which is very slightly dissociated, and may therefore be regarded as not conducting at all; molecules of hydrochloric acid, which also do not conduct, for the hydrogen and chlorine have equal but opposite charges, and as they move together they cannot assist a convection current; and, finally, the solution consists of loose charged atoms of hydrogen and chlorine. They cannot be separated by diffusion as in ordinary cases of dissociation, for as soon as the faster-moving ions begin to diffuse into a new liquid their charges alter the potential of the liquids and thus the electric force comes into play, keeping back the fast and helping the slow and oppositely-charged ions. For every atomic equivalent of electricity that passes through the cell of dilute acid an atom of chlorine comes off at the anode and of hydrogen at the cathode. There are thus two atoms removed from the electrolyte by the passage of the electric charge of a single atom through the cell. If there were no movement of the ions, there would then be a hydrogen atom close to the anode and one of chlorine at the cathode. As soon as there is an excess of atoms of this sort there is a difference of potential between the sides of the electrolyte, and this causes the ions to move across. If they moved equally for every two atoms of chlorine and two of hydrogen deposited on the electrodes, there would be a movement of one atom of chlorine and one of hydrogen in opposite directions across any surface separating the electrodes, and the liquid in the neighbourhood of the electrodes would be equally impoverished as to hydrochloric acid. But suppose the hydrogen atoms move five times as fast as the chlorine for every six atoms of chlorine and six of hydrogen given off at the electrodes, five atoms of hydrogen and one atom of chlorine will pass an imaginary partition in opposite directions. The anode liquid will thus be impoverished by five molecules of hydrochloric acid, but the cathode solution will only lose one.

Space will not permit of a fuller account of electrolytic theory, and I must pass on to practical work, mentioning only a few processes.

The Ashcroft Process.

One of the most interesting of the more recent electrolytic processes is the Ashcroft method of treating the Broken Hill ores. As far as I know this process has never been fully described in print; in fact, I do not know that it has been described at all. The directors have very kindly given me permission to explain it as fully as I can, so I take the opportunity of doing so.

As is generally known, the Broken Hill mines contain enormous quantities, in fact, millions of tons of argentiferous sulphide of lead and zinc. Where this has been exposed to the weather for many thousands of years, the zinc and lead sulphides have been oxidised, and the zinc salts have been washed away. The lead and silver are then very easily dealt with metallurgically. The exposed and oxidised ore is nearly done now. Although enormous quantities of lead and silver have been taken from the Broken Hill mines, all that has been done so far is but a mere scratching of the surface compared with what there is still to do. The sulphide of lead and zinc is, however, a very troublesome ore to deal with. The zinc prevents its being treated as a lead ore, and the enormous mass has been regarded as valueless until some process for treating could be discovered. The lead and zinc sulphides are very intimately mixed, so that

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concentration is exceedingly difficult. Of course, there have been endless schemes for the treatment of this ore, and probably every inventor in Australia has devoted some attention to the matter, but until the Ashcroft process was invented nothing very promising had been brought forward.

The Broken Hill ore may be taken to consist, roughly, of 30 per cent. of lead as sulphide, 30 per cent. of zinc as sulphide, and 25 to 30 ounces of silver to the ton. There is not much gangue.

In the Ashcroft process the ore is first ground—not too fine—and then roasted. This converts the zinc sulphide mainly into oxide. Of course the sulphide can be roasted till practically all the zinc is in the form of oxide, but it is most economical in this case not to roast so far. It will be said that this involves waste of zinc in the form of solution of sulphate, but the zinc at this stage is practically of no value. It pays better to allow a certain amount of zinc to be wasted rather than to go to the expense of roasting into oxide.

The roasted ore is then leached with a solution containing persalts of iron, and salts of zinc, sulphates, and chlorides. The oxide of zinc in the roasted ore is dissolved as sulphate or chloride, while the iron is precipitated as ferric hydrate. The ferric hydrate is apt to remain in its colloidal form, but the solution is heated and the iron thrown down. The solid matter is allowed to settle and the solution is run off. The solid matter contains all the lead and some of the silver, and some zinc. There is so little zinc, however, that it gives no trouble in smelting. The iron oxide is also required for smelting, and would have to have been added in any case.

The solution is led through tanks containing zinc plates or shavings to catch any silver. It then goes to electrolytic vats, and some of the zinc is taken out. The anodes in these vats are iron, so that iron goes into solution as ferrous chloride or sulphate. A diaphragm is used, to prevent the solution mixing. The mixing of the solutions would be fatal to the process, because iron would be deposited on the zinc. This would not only give zinc containing iron, but it would prevent the zinc coming down properly. It is by no means easy to produce a smooth, even deposit of zinc of any thickness; and as soon as a deposit begins to come down badly, it is very troublesome to get it right again. In order to prevent any chance of iron getting into the cathode chamber, the liquid on this side is kept at a slightly higher level, so that there is always a current through the diaphragm which prevents any trace of iron getting in. The liquid from the cathode chamber which has been deprived of some of its zinc, is led to a second set of vats in which more of the zinc is taken out. The solution is then led to the anode chamber first described, so as to take up iron in the ferrous stite. The ferrous solution is then led to the last vat, which has carbon anodes instead of iron. This converts the iron into ferric salts, and this solution, which contains ferric and zinc salts, is used for leaching the roasted ore. The process is thus cyclic.

Most people who have had experiences of leaching processes may be inclined to think that there must be difficulty in getting the iron completely thrown down by the roasted ore. The leaching, however, goes beautifully at once, and, after heating to deposit ferric oxide, there is no trace of iron to be found in the solution. It is necessary, of course, to have excess of zinc oxide, to make sure that all the iron is thrown down. Traces of aluminium and manganese salts may find their way into the solution, but that does not matter, as they cannot accumulate beyond a certain amount, as will be explained immediately.

The leached ore and oxide of iron contains a good deal of solution, so that a certain amount of zinc salts is taken with it. As the clear solution is separated from the sludge by decantation, and the sludge is still liquid enough to be run off into settling-tanks, it might be that it would pay to save the solution of zinc—but this is not the case. If the solution could be perfectly separated so that none was thrown away, and no new solution was added, the impurities would accumulate until they gave trouble in the depositing-vats. A certain proportion of the solution is therefore allowed to go off with the slimes, and the solution is made up with sea-water.

As explained already, the roasted ore contains zinc in the form of sulphates and of oxide. A basic sulphate may for the moment be regarded as a mixture of oxide and sulphate. The circulating system thus consists of a stream of solution which after leaving the leaching vats has its silver removed and then goes through cathode chambers, where about one-third of its zinc is taken. It then goes through anode chambers while it takes up the iron, which in the second set of anode chambers is converted into the ferric state, and the ferric salt is changed for zinc salt in the leaching.

It is only zinc in the form of oxide that is taken up in the ferric solution; that in the form of sulphate goes into the solution without any corresponding precipitation of iron. This zinc is useless, as it cannot be deposited in the tanks. All the zinc taken up as sulphate by simple solution is thus wasted. This is a very curious result, but a little consideration will show that it must be so. The zinc deposited in the vats is, of course, accurately in proportion to the iron dissolved. The vats must be arranged so that the iron anodes have twice the current of the carbon vats, otherwise there would be chlorine liberated, or ferrous salts in the leaching solution as the case might be. This result is easily secured by having two iron vats in series with one carbon cell. Suppose two gramme equivalents of zinc—that is to say, 130 grammes of zinc—are deposited in the cells with iron anodes, two gramme equivalents of iron—that is to say, 112 grammes—are dissolved as ferrous salt; in the next cell, with carbon anodes, the ferrous salt is raised to the ferric state, and another gramme equivalent of zinc is thrown down. For every three gramme equivalents of zinc we thus have two gramme equivalents of iron, and two gramme equivalents of ferric salt act on three gramme equivalents of zinc oxide in the leaching vats. The zinc deposited is, therefore, equivalent to the iron, and is thus the zinc that is taken up by action of the ferric salt on the oxide. If the same liquid always circulated without any being drawn off, the zinc would increase till the solution was saturated as regards zinc sulphate. The zinc sulphate is therefore drawn off to some extent with the slime after leaching. It may be utilised by other processes, but as far as this process goes it is a waste product. It still pays, however, not to trouble to roast the zinc sulphide completely into oxide.

Only about a third of the zinc is removed from the solution during one tour through the electrolysis-house. There has always been some difficulty in getting a good, smooth, dense deposit of zinc. It is very apt to come down in a spongy form, and in this case it is practically impossible to deposit it commercially. For that reason many people have advocated the use of alkaline solutions of zincates, such as the solution of zinc oxide in caustic soda. On the other hand, zinc sulphate will sometimes give very perfect deposits, and zinc sulphate was the electrolyte employed in the Edison electrolytic meter, where it seemed to work with almost perfect success. The deposition of zinc on a large scale from the sulphate has, however, generally given great trouble. In the Ashcroft process this trouble is overcome by the use of a solution containing basic sulphate and chloride of zinc. There is always excess of zinc oxide in the ore—that is to say, in leaching, the roasted ore and iron solution are so proportioned that there is more oxide than the iron can deal with. Though the basic salts of zinc are insoluble in water, they are fairly soluble in solutions of the corresponding neutral salts, so that the electrolyte really contains basic salts. This seems to make all the difference in the nature of the deposit. Even then the deposit is somewhat brittle. New wooden vats will sometimes add something to the solution which makes the deposit come down badly.

The vats are wooden tanks, and the cathodes are sheets of zinc suspended in cells which are dropped into the larger cells. The diaphragms are made of close texture canvas. The anodes are crude wrought iron. It is probable that crude pig iron will do, but cheap wrought iron is at present used. The circulation is arranged so that the current of liquid through the cathode chambers is quite distinct from the anode circulation; the liquid in the cathode chambers being kept at a little higher level as already explained, so as to make sure that no iron gets into the cathode cells. For the carbon electrodes either plates or rods of the same material as electric light carbons are used. This material is, of course, expensive, but it is not practicable to arrange for retort carbon, or any other cheap substitute, as, to get a reasonable output from a given area of a vat-house, the vats have to be deep. The circulation systems make it difficult to have sets of shallow vats one above the other. The carbon is attacked to some extent, but the corrosion is small, as there is plenty of chloride available. The oxidation has to be carried a trifle further than would suffice for the complete conversion of the ferrous into a ferric salt, so that a trace of chlorine or hypochlorite is formed. This oxidises any traces of ferrous salt that may not have come into contact with the anodes. It is most important to have no ferrous salt in the leaching vats, as they are not precipitated by zinc oxide, and would find their way into cathode vats, and spoil the deposit.

This process is the invention of Mr. Edgar A. Ashcroft, and is now owned by the Sulphide Corporation (Ashcroft's Process), Limited, who are commencing to work it in Australia. This company also owns a block of the Broken Hill mines, so that they have an almost unlimited supply of raw material to work upon. The process has already been worked on a manufacturing scale, and works are now being started in Australia and the United States.

Telegraphists' Strike.—A strike of the telegraph operators employed on the Canadian Pacific Railway has been ordered by the executive of their union. The majority of men working on the main line from St. John, New Brunswick, to Vancouver have left work, but on the Ontario lines the strike does not appear to be general, and things are better there than on any other part of the system. From Montreal to Quebec, and eastward to St. John and northward to Chalk River, the bulk of the operators are out. The strikers are badly organised and their funds are small, and the company's officials say they can get hundreds of operators from the United States, so that not much inconvenience is likely to be caused.

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ELECTRICALLY-EQUIPPED RAILWAYS.

The additional information given by Mr. Cottrell in his paper on the "Liverpool Overhead Railway" to the Mechanical Section of the British Association is of considerable interest. It is somewhat difficult to state definitely where a light railway in contradistinction to a tramway begins, also where the light railway ends and the ordinary railway begins. Far too many, and we think for the most part absurd, comparisons have been made between what ought to be considered light railways electrically equipped in America and horse or electrically equipped tramways in England. You might just as well compare a poker and a pug dog. The same sort of comparison and attempted booming is going on with horseless motors. Syndicates and patentees whose aim is to make money are attempting to push into notoriety vehicles that have no more chance of general adoption than the old-fashioned war chariots of the ancient Britons. Horseless carriages will come, but they will not come with a great rush, and very great advances must be made in their construction before they can be deemed practical. We protest against all these misleading comparisons. Even in the case of the two electric railways in England—the one at Liverpool, the other in South London—they cannot be unreservedly compared with steam-equipped railways, because in the one case steam was altogether inadmissible, in the other only probably admissible. In both cases, in fact, electricity stood out far and away before every other kind of traction. We are glad, therefore, to see that in this paper no comparisons are made except between the two electrically-equipped railways. These, again, have little in common except that of electrical equipment. The London railway is almost entirely in a deep tunnel; the Liverpool, as its name shows, is overhead. Lessons have to be derived from each, for each supplies a unique case. Of course, similar or somewhat similar positions exist, and the success of these first attempts is leading to similar lines elsewhere. In Liverpool extensions have been and are being made, such extensions adding much to the utility of the original line. In London new lines as well as extensions, some connected with the original, some quite distinct, are being rapidly pushed on. Perhaps the most important experience to guide future workers is given in the two lines of statistics dealing with expenditure per train mile and revenue per train mile. Upon the ratio of these failure or success depends. At Liverpool the expenditure per train mile has been gradually increasing, a by no means good sign. Two years ago it was 13·10d., now it is 15·10d., or exactly 2d. per train mile increase. This may perhaps be accounted for in some simple manner, but we cannot from the statistics given see the reason. Certainly the number of passengers carried has increased about 100,000, and the mileage decreased about 1,400 miles, showing extra weight carried, but we doubt if this adds more than a small fraction of a penny to the mileage cost. The difference between the expenditure and revenue per train mile is 8·85d. now in favour of

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revenue at Liverpool, while at London it is 10·34d. The expenditure per train mile in London is fairly constant, fluctuating perhaps about 0·5d. It can easily be seen that if such expenditure increases at a greater pace than revenue, the outlook is not so good as when the latter increases fastest. There is just one other point in these figures to which we might direct attention. At Liverpool the charge is by the zone system, and only first-class tickets are issued, the other class receiving no tickets; thus a saving is effected in printing and clerical work. The charge, too, is less than at London; yet the value per passenger at Liverpool is 1·97d., as against 1·72d. at London. As might have been expected in working new undertakings, improvements are being made which ought to add still more to successful working. The most important of these pointed out by Mr. Cottrell is the introduction of an ingenious form of roller bearings, the use of which it is expected will increase the carrying capacity of all trains by an additional carriage.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

SOUTH SHIELDS ELECTRICAL SUPPLY STATION.

SIR,—In reference to your account of the above, I have a correction to make in respect of the statement as to planning and supervision of the buildings for which I hope you will find room

Your account says that I was clerk of works and also get out the bills of quantities in the first instance. To those who are closely connected with the building trade, such a statement as that would carry with it a suspicion that something was wrong.

The fact is that Mr. Jeckell had nothing to do with the designs, plans for, or superintendence of, the buildings and engine foundations. I throughout acted as architect to the building, and except a rough plan showing the relative positions of the various departments—such as any person intending to build could have made—I had no assistance whatever from Mr. Jeckell.

I enclose a similar communication which I made to a local paper, to which Mr. Jeckell has never replied, and the note added to same by the editor shows clearly where the blame lies. FRED. RENNOLDSON.

X RAYS.

At the meeting of the British Association in Liverpool this year a good deal of discussion took place regarding the various properties of Lenard rays, Becquerel rays, kathode rays, and Röntgen rays, which showed that great diversity of opinion still exists as to their theoretical and physical explanation. In the year 1893 Lenard made a remarkable series of experiments. He had a cylindrical tube with a kathode at one end which was either flat or concave, and he had the other end closed with a piece of thin aluminium foil. To this end of the tube was attached another tube which could be separately or concurrently exhausted with the first tube.

Lenard found that when the first tube was moderately exhausted, the kathodic rays in it were transmitted through the aluminium window into the second, and the distance to which they penetrated in the second tube before they became invisible through dispersion was greater the less the pressure of the air in the tube. When the second tube was exhausted for days, so that there was very little gas, if any, left in the tube, the rays were traced at a distance of more than a metre from the aluminium window. These Lenard rays, both in the first and second tube, are deflected by a magnet to about the same extent. Lenard himself believes that these rays are like light waves, or that they are, as he terms it, processes in the ether. The prevailing opinion amongst physicists in this country is that the kathodic rays in the first tube consist of molecules (gas or metal, or both) highly negatively charged. These impinging with great velocity on the aluminium window give rise to similar molecular discharge on the other side of the window, although the molecules themselves do not pass through the window.

Röntgen announced his discovery in the beginning of this year. His rays differ from the kathodic rays in not being deflected by a magnet, and apparently from ordinary light waves (1) in being transmitted by substances which are opaque to light; (2) in not being deflected unless to a small extent at a grazing incidence; (3) in not being refracted when allowed to pass through prism-shaped bodies; (4) in not being polarised; (5) in showing no diffraction.

The president of Section A, Prof. J. J. Thomson, in his presidential address ably and clearly showed that the absence of refraction and polarisation is no proof against the Röntgen rays being a form of light of very small wave-length. A curve from a paper by Helmholtz was shown. If the molecules of a substance have a natural period of vibration, and one only, the refractive index increases with the frequency of the light until the latter is equal to the frequency of the natural vibration of the substance. Then the refractive index diminishes, becomes less than unity, finally approaches unity, and becomes practically unity when the frequency of the vibration greatly exceeds the frequency of the natural vibration of the molecule.

Thus it was concluded that "the absence of refraction, instead of being in contradiction to the Röntgen rays, being a kind of light, is exactly what we should expect if the wave-length of the light were exceedingly small."

Similarly, for the absence of polarisation, tourmaline is fine-grained enough to polarise ordinary light, but it may be necessary to have a polariser of a much finer structure before we can get evidence of polarisation in Röntgen rays.

Lenard restated his views to the section, and adheres to the belief that both the Lenard and Röntgen rays are forms of light or that they are rays due to a disturbance in the ether. Sir George Stokes supposed that kathode rays on one side of the aluminium window gave rise to kathode rays on the other side of it by a process analogous to that of electrolysing copper sulphate with copper electrodes and inserting a copper plate between the electrodes. Copper ions come up to the plate on one side and leave it on the other, but do not pass through it. Similarly he supposed that kathode rays, which are negatively charged material particles, perhaps of gas, but equally probably of disintegrated electrode, strike the aluminium on one side, and the violence of the impact gives rise to a projection of molecules from the other side of the window. These projected particles on the other side of the window might have greater or less velocity than the original kathodic stream. Lenard objected to this explanation inasmuch as the deflectability of the kathode rays by a magnet is unaffected by the window. They are equally deflected in the vacuum tube and outside it.

The Röntgen rays Sir George Stokes was disposed to believe to be a sudden and non-periodic disturbance of the ether, either longitudinal or transverse to the direction of its propagation, the disturbance being repeated at each impact of a molecule against the surface from which the Röntgen rays emanate. On this supposition of a non-periodic disturbance there would be no diffraction, as a succession of the timed impulses is necessary for such phenomena. The same supposition would account for diffusion and luminosity in a turbid medium—such as air at ordinary pressure.

The following are some of the properties and effects of the Röntgen rays which were specially brought to the notice of the section: Thomson and Rutherford found that a gas while transmitting Röntgen rays is a conductor of electricity. The conductivity is destroyed if a current of electricity is sent through the Röntgenised gas. The strength of the current through gas exposed to Röntgen rays is, if small, proportional to the E.M.F.; but as the E.M.F. is

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increased the current is not nearly increased in the same proportion, but tends to a value where it is almost constant and independent of the E.M.F.—that is, the current destroys and the rays produce the structure which gives conductivity to the gas, and a steady state is finally reached in which the rate of destruction by the current is equal to the rate of production by the rays. The conductivity under the Röntgen rays varies greatly from one gas to another. The vapour of mercury, which under ordinary circumstances is a good insulator, was found to be one of the best conductors.

Rücker and Watson noticed while experimenting on the transparency of glass and porcelain to the Röntgen rays that if a vacuum tube ceases to give Röntgen rays by reason of its resistance becoming too low, on coating the outside with tinfoil the rays appeared again. If the resistance is too high, heating the tube is the best remedy, as is well known. Trouton found that the duration of the Röntgen radiation at each spark varied from $\frac{1}{800}$th to $\frac{1}{10000}$th of a second. Thompson described some experiments with a Crookes tube, and various screens including aluminium of different thicknesses, and a mica plate covered with fluorescent material. In one set of experiments he used a concave kathode and a flat anode set at an angle of 45deg. to the axis of the anode. The rays from the kathode were reflected from the anode and produced shadows of two wires in their path. These rays on emergence from the tube still gave the shadows of the wire, but while the rays in the tube could be deflected by a magnet those outside could not be deflected. He found that arc light could send radiation through pinewood, but not through aluminium, which would cast a shadow of an obstacle on a photographic plate. Calcium sulphide gives off radiation even after retention in a dark room for six weeks. Cathode rays falling on uranium give rise to a more intense radiation of Röntgen rays than when they fall on platinum. The Becquerel rays, rays given off by fluorescent substances, especially uranium salts, after exposure to light, pass through aluminium and other opaque bodies so as to give photographs like Röntgen rays; discharge electrified bodies more readily than Röntgen rays; possess various degrees of refrangibility; can be reflected and polarised, and hence unquestionably are light. X.

ELECTRIC GLOW LAMP TESTS.*

BY WILLIAM HENRY PREECE, C.B., F.R.S., ETC.

(Continued from page 349.)

INSTALLATION TESTS.

In the case of Experiments 2 and 4, the lamps were rigidly mounted in suitable holders upon a stout shelf, fixed to a massive wall, so that no undue vibration should tend to shorten their life. The first group tried comprised two 8-c.p. lamps and two 16-c.p. lamps, as received from each of the firms mentioned against Experiment 2 in the above list, while a second batch of lamps comprised one 16-c.p. and one 8-c.p., as supplied by each firm named against Experiment 4. Two circuits were formed—one for 100-volt and one for 105-volt lamps, on identically the same system as that described for the continuous lighting tests. The illuminating power and current of each lamp at its normal voltage were taken before the trials commenced. Daily electrical measurements were made of each pair of lamps during the trial, and at the conclusion of the trial the existing lamps were again photometrically and electrically examined. If a lamp broke within the allotted 1,000 hours' run, it was immediately replaced by another of the same make and kind of known efficiency. Hence, in the two following schedules, lettered respectively C and D, the number of lamp corresponds to the first, second, third, fourth, etc., lamp installed. The so-called economical or high-efficiency lamps evidently suffered more than those of about 3¾ watts per candle. In some cases the life was less than that of the same sort of lamps in the continuous lighting tests, while in other cases no difference was observable. Of seven economical lamps supplied by one firm, five of the filaments broke within 1,056½ hours. Schedules C and D also show the life of each lamp, the current at start and finish, and the candle-power of those lamps burning at the conclusion of the trial. The longest run was 1,056½ hours and the shortest 23¾ hours. Omitting these numbers and others below 100, the average life of eight 16-c.p. 105-volt lamps was 463·47 hours, and of three 8-c.p. 100-volt lamps 556 hours. Schedules C and C_1 include the same kind of lamps as those bracketed against Experiments 1 and 2 in the preceding list, and Schedule D embraces lamps similar to those named in the same list opposite Experiments 3 and 4.

* Paper read before the British Association at Liverpool.

EXPERIMENT 5.—BREAKING VOLTAGE.

Having obtained a fairly good knowledge of the efficiency and durability of various glow lamps, under conditions of constant illumination and intermittent lighting, I next attempted to determine a quick and ready way of satisfactorily judging the quality of lamps. To obtain this end the voltage of several of the lamps already referred to was gradually run up for each lamp singly at a uniform rate until the filaments broke. At the moment of rupture the voltage, current, and time of running up were noted in each case. Before increasing the normal voltage, the current of every lamp was carefully measured, and the resistance (hot) afterwards calculated. In later trials the resistance (cold) was also found. The following table (1) gives full particulars of the average breaking voltage of lamps supplied by some of the firms before mentioned. It also shows the average current, resistance (hot), time of running up, and the difference in volts, amperes, watts, and the resistance (hot) between the normal requirements of the particular lamps and their breaking voltage. The four mean factors alluded to at breaking point are diagrammatically represented after the table of results. A suitable gearing controlled the motion of a falling electrode of copper as it gradually dropped through a column of very weak dilute sulphuric acid, which, on a 350-volt circuit, allowed the pressure of the lamp to be slowly raised to the breaking point. One assistant noted the volts and manipulated a chronograph, while another recorded the current at moment of collapse. Several lamps of like voltage and candle-power were obtained from various firms, and had their filaments broken in this manner. The average breaking voltage of the filaments was found to be 230.

EXPERIMENT 6.—THREE-FOURTHS OF BREAKING VOLTAGE.

Another series of tests were carried out in the same way as Experiment 5, except that the lamps were tested electrically and photometrically after, as well as before, being subjected to a high voltage. The object was to find what would be the effect on the electrical efficiency, candle-power, and the resistance of the same kind of lamps, when slowly raised from normal pressure to three-fourths of their mean breaking voltage. It is interesting to notice in Table 2 below that the candle-power is found to be rather more after the filaments have been raised to a high temperature and retested at the initial pressure.

From the trials of the numerous lamps that have been supplied to the Post Office, Table 3 has been calculated, showing their behaviour before and after being raised to three-quarters of their breaking voltage. They have been arranged in order of their initial efficiencies, and the percentage difference of candle-power and watts per candle-power before and after raising the voltage exhibited in tabular form. With the exception of the watts per candle-power in the case of the group of lamps of the initial efficiency 4 to 4·5, these differences are positive.

TABLE 3.—Table showing Behaviour of 16-c.p. Lamps (100 volts and 105 volts) before and after raising their voltage to 170.

Initial efficiency watts per C.P.	No. of tests.	Before raising voltage.		After raising voltage.		Mean differences per cent.	
		Mean C.P.	Mean watts per C.P.	Mean C.P.	Mean watts per C.P.	C.P.	Watts per C.P.
3·0-3 5	29	15·8	3·34	16·1	3·45	+ 1·9	+3·3
3 5-4·0	93	14·5	3·76	15·5	3·81	+ 6·9	+1·3
4·0-4·5	66	13 3	4·19	14·86	3·85	+11·7	-8·1
4·5 5·0	17	12·7	4·69	13·1	4·91	+ 3·1	+4·7

The foregoing results may be summed up thus:

1. The continuous lighting experiments show that the candle-power falls about 30 per cent. in 1,000 hours, and the watts per candle rise about 28 per cent. in the same time, as illustrated in the curves below (Sheet 1.), which connect time with candle-power (percentage) and watts per candle.

2. In installation work lamps of about 3¾ watts per candle, burning from seven to nine hours a day, behave as regards life and efficiency about the same as when given continuous illumination, but high-efficiency lamps deteriorate more quickly.

3. That good 100 or 105 volt 16-c.p. lamps, taking 3¾ watts per candle, should stand a gradual increase of pressure of direct current up to 225 or 230 volts (now made 210) in 3½ minutes before the filament breaks; that when slowly and regularly raised in 2½ minutes to, say, 170 volts—that is, approximately three-fourths of the mean breaking voltage previously alluded to—and afterwards retested at ordinary voltage, the candle-power should not be less than 14·4 nor

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SCHEDULE C.—SUMMARY OF ORDINARY INSTALLATION TEST.—Lamps 105 and 100 volts, 16 c.p. Two Lamps of each Maker in Parallel.

Firm.	Date of starting.	Lamps in parallel.	Current in amperes At start.	Current in amperes At finish.	Lamp. Broke.	Lamp. Date.	Numbers of lamps. Lamp hours. (* Unbroken.) 1	2	3	4	5	6	7	Candle-power at finish.
Edison - Swan. 105		Nos.												
volts	Feb. 1	1 and 2	1·17	1 15	No. 2	Feb. 26	—	115	—	—	—	—	—	—
	,, 26	1 ,, 3	1·14	1·09	No. 1	May 1	471	—	—	—	—	—	—	No. 3 11·4
	May 1	3 ,, 4	1·10	1·10	—	—	—	—	1030·5*	597*	—	—	—	,, 4 12·3
Siemens Bros. 105														No. 1 9·4
volts	Feb. 1	1 ,, 2	1 14	1·04	—	—	1056·5*	1056·5*	—	—	—	—	—	,, 2 10 0
Brush Co. 100 volts...	Feb. 1	1 ,, 2	1 13	1·06	—	—	1056·5*	1056·5*	—	—	—	—	—	No. 1 9·6
Laing, Wharton, and														,, 2 11·6
Down. 105 volts...	Feb. 1	1 ,, 2	1·01	0·97	No. 1	Mar. 28	213·5	—	—	—	—	—	—	—
	Mar. 28	2 ,, 3	1·01	0·91	No. 3	July 4	—	—	678	—	—	—	—	No. 2 3·8
	July 4	2 ,, 4	0·93	0·92	—	—	—	1056·5*	—	186*	—	—	—	,, 4 11·7
Stearn. 105 volts......	Feb. 1	1 ,, 2	1·17	1·12	No. 1	July 14	945·5	—	—	—	—	—	—	No. 2 12·9
	July 14	2 ,, 3	0·93	0·92	—	—	—	1056·5*	102*	—	—	—	—	,, 3 14 8
International Electric														
Co. 105 volts	Feb. 1	1 ,, 2	1·24	1·10	No. 1	May 17	566	—	—	—	—	—	—	No. 2 10·8
	May 17	2 ,, 3	1·08	1·02	—	—	—	1056·5*	450·5*	—	—	—	—	,, 3 10·9
Bishop's Cluster Co.														No. 1 10·3
105 volts	Feb. 1	1 ,, 2	1·11	1·04	—	—	1056·5*	1056·5*	—	—	—	—	—	,, 2 9·7
Electrical Co. 105 volts	Feb. 1	1 ,, 2	0·78	0·71	No. 1	Feb. 10	23·75	—	—	—	—	—	—	—
	,, 10	2 ,, 3	0·72	0·70	No. 2	,, 17	—	69	—	—	—	—	—	—
	,, 19	3 ,, 4	0·72	0·71	No. 3	,, 20	—	—	53·75	—	—	—	—	—
	,, 20	4 ,, 5	0·71	0·68	—	—	—	—	—	1006·5*	—	—	—	—
	Mar. 8	4 ,, 6	0·70	0·56	No. 5	Mar. 8	—	—	—	—	101·5	—	—	No. 4 4·3
	June 11	4 ,, 7	0·60	0·56	No. 6	June 11	—	—	—	—	—	532·75	328·5	,, 7 6·5
Sunbeam lamp. 105														No. 1 6·8
volts	Feb. 1	1 ,, 2	1·10	1·07	—	—	1014·5*	1014·5*	—	—	—	—	—	,, 2 6·9

SCHEDULE C₁.—SUMMARY OF ORDINARY INSTALLATION TEST.—Lamps 100 volts and 8 c.p. Two Lamps of each Maker in Parallel.

Firm.	Date of starting.	Lamps in parallel.	Current in amperes. At start.	Current in amperes. At finish.	Lamp. Broke.	Lamp. Date.	Number of lamps. Lamp hours. 1	2	3	4	Candle-power at finish.	Remarks.
Edison-Swan. 100 volts		Nos.										16 nominal
16 c.p.	Feb. 1	1 and 2	1·24	1·22	—	—	1056·5	1056·5	—	—	No. 1 12·2	candle-
							unbr	oken			,, 2 12·3	power.
Siemens Bros. 100 volts...	Feb. 1	1 ,, 2	0·75	0·66	—	—	1056·5	1056·5	—	—	No. 1 9·4	—
							unbr	oken			,, 2 10·0	—
Brush Co. 100 volts	Feb. 1	1 ,, 2	0·55	0·51	—	—	1056·5	1056·5	—	—	No. 1 6·5	—
							unbr	oken			,, 2 3·7	—
Laing, Wharton, and Down.	Feb. 1	1 ,, 2	0·60	0·52	No. 1	May 18	574	—	—	—	—	—
100 volts.		2 ,, 3	0·57	0·53	—	—	—	1056·5	480·5	—	No. 2 3·2	—
								unbr	oken		,, 3 5·8	—
Stearn. 100 volts	Feb. 1	1 ,, 2	0·55	0·46	No. 2	April 4	—	258·25	—	—	—	
		1 ,, 3	0·52	0·48	No. 1	June 27	835·5	—	—	—	—	10 nominal
		3 ,, 4	0·53	0·51	—	—	—	—	787·5	222·5	No. 3 5·1	candle-
									unbr	oken	,, 4 5·9	power.
International Electric Co.	Feb. 1	1 ,, 2	0·68	0·60	—	—	1056·5	1056·5	—	—	No. 1 5·4	—
100 volts.							unbr	oken			,, 2 6·5	—
Bishop's Cluster Co. 100	Feb. 1	1 ,, 2	0·81	0·79	—	—	1056·5	1056·5	—	—	No. 1 6·2	—
volts.							unbr	oken			,, 2 4·9	—
Electrical Co. 105 volts...	Feb. 1	1 ,, 2	0·45	0·39	—	—	1056·5	1056·5	—	—	No. 1 3·0	—
							unbr	oken			,, 2 2·7	—
Sunbeam Lamp Co. 100	Feb. 13	1 ,, 2	0·85	0·83	—	—	1016·5	1016·5	—	—	No. 1 8·5	—
volts.							unbr	oken			,, 2 5·4	—

SCHEDULE D.—SUMMARY OF ORDINARY INSTALLATION TEST.—Lamps of 105-volts, 16 c.p. and 8 c.p. Two Lamps of each make in Parallel.

Firm.	Date of starting.	Lamps in parallel. 16 c.p.	Lamps in parallel. 8 c.p.	Current in amperes. At start. 16 c.p.	At start. 8 c.p.	At finish. 16 c.p.	At finish. 8 c.p.	Lamp. Broke.	Lamp. Date.	Lamp hours. 1	2	3, 4, 5, 6†	C.P. At start.	C.P. At finish.
		No.	No.										No. 1 10·6	12·5
Conze and Simon	Sept. 21/94	1	2	0·60	0·27	0·64	0·29	—	—	107	6·5*	—	,, 2 4·5	6·4
Barclay and Son	Sept. 21/94	1	2	0·49	0·26	0·51	0·24	No. 1	Jan. 16/95	759	1076·5*	—	6·2	5·6
	Jan. 16/95	3	—	0·51	—	0·52	—	—	—	—	317·5*	—	—	—
Stürm and Co.	Sept. 21/94	1	2	0·60	0·28	0·63	0·28	,, 2	Oct. 5/94	1076·5*	92·75	—	10·4	13·3
	Oct. 5/94	—	3	—	0·28	—	0·27	,, 3	Nov. 1/94	—	—	[3]191·25	—	—
	Nov. 1/94	—	4	—	0·27	—	0·28	,, 4	Jan. 10/95	—	—	[4]436 5	—	—
	Jan. 10/95	—	5	—	0·28	—	0·28	,, 5	Jan. 21/95	—	—	[5]64	—	—
	Jan. 21 95	—	6	—	0·28	—	0·25	,, 6	Mar. 2/95	—	—	[6]295*	—	—
Walters and Co.	Sept. 21	1	2	0·54	0·37	0 54	0·34	—	—	107	6·5*	—	No. 1 12·8	9·8
													,, 2 7·3	7·3
Electrical Co.	Sept. 21	1	2	0·63	0·29	0·62	0·25	—	—	107	6·5*	—	No. 1 15·0	12·0
													,, 2 8·7	5·4
General Electric Co. ...	Sept. 21	1	2*b*	0·66	0·70*d*	0·66	—	,, 1	Oct. 27/94	248	—	—	—	—
	Oct. 29/94	3	—	0·70	—	0·65	0·67*f*	,, 2	Dec. 3/94	—	—	[3]824·5*	—	—
	Dec. 3/94	—	4	—	0·67	—	0·68	,, 4	Jan. 29/95	—	—	[4]390·5	—	—
	Jan. 29/95	—	5	—	0·68	—	0·70	—	—	—	—	[5]233*	—	—
G. Straus	Sept. 21/94	1*a*	2*c*	0·58	0·35*e*	0·62	0·35*g*	,, 2	Feb. 28/95	1076·5*	1058	—	13 0	11·3
	Feb. 28/95	—	3	—	0·35	—	0·35	—	—	—	—	19·5*	—	—
Lowcock, Hill, and Co.	Sept. 21/94	1	2	0·51	0·36	0·54	0·35	,, 1	Jan. 14/95	739·5	1076·5*	—	7·0	6·4
	Jan. 14/95	3	—	0·54	—	0·54	—	—	—	—	—	337*	—	—
Rose and Bird	Sept. 21/94	1	2	0·54	0·30	0·56	0 32	—	—	107	6·5*	—	No. 1 14 8	12·4
													,, 2 5·5	7·1

(*a*) 105 v., 16 c.p. (*b*) 100 v., 16 c p. (*c*) 105 v., 9 c.p. (*d*) 100 v., 16 c.p (*e*) 100 v., 8 c.p. (*f*) 100 v., 16 c.p. (*g*) 105 v., 8 c.p.
* Unbroken. † The superior figure denotes whether 3, 4, 5 or 6 lamp hours.

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higher than 17·6, while the watts per candle should not exceed 4.

Evidently, in ordinary lighting, the candle-power of each lamp gradually drops and the watts per candle rise; but when the pressure is raised in a short time to three-fourths of the breaking voltage the candle-power increases, and so also does the current, but the first more rapidly than the second, hence the watts per candle should not exceed four for lamps of 3¾ watts per candle after the increased pressure has been applied to the filaments. This is rather a curious fact, and seems to indicate that when the filament is raised to a temperature considerably above that of normal, it, if of good quality, undergoes a beneficial change, as if the sudden cooling, after being at an abnormal temperature, causes some molecular alteration, which not only lessens its diameter and resistance, but affects its emissivity. Under these conditions the temperature of the filament is increased, and thus produces a greater amount of light.

To ascertain the characteristic behaviour and actual cost of various lamps referred to in this paper I have selected a number indiscriminately and divided them into three groups according to their initial efficiency, thus:

1. Those taking from 2 to 3 watts per candle. Sheet 2. Group F.
2. ,, ,, ,, 3 to 4 ,, ,, ,, ,, ,, G.
3. ,, ,, over 4 to ,, ,, ,, ,, ,, H.

Group F included three lamps only. Group G 19 lamps, and Group H 14 lamps, and it was so arranged that these numbers were maintained throughout 1,000 hours by renewal of lamps whose initial efficiencies were within the limits specified for that particular group. Three tables have been calculated, giving at intervals of 100 hours the candle-power per lamp, the watts per candle per lamp, and the total number of lamps replaced, and the results are plotted upon Sheets 2 and 3. Sheet 2 connects time with the candle-power and watts per candle per lamp for each group, and the curves thereon correspond with the results tabulated below.

TABLE 4.—Table showing Candle-Power per Lamp, Watts per Candle per Lamp, and Time.

Lamps of Initial Efficiency = 2-3 Watts per Candle.

Time, hours.	No. of lamps.	C.P. per lamp.	Watts per candle per lamp.	Lamps replaced. Total.	Remarks.
0	3	12·57	2·72	0	Therefore in 1,000 hours each of the original three lamps had been replaced, and one twice.
100	,,	10·02	4·57	0	
200	,,	13·25	3·57	1	
300	,,	12·25	3·7	1	
400	,,	11·69	3·73	1	
500	,,	12·64	3·6	2	
600	,,	10·04	3·77	3	
700	,,	8·81	4·34	3	
800	,,	8·24	4·55	3	
900	,,	8·09	4·72	4	
1,000	,,	7·83	4·84	4	

TABLE 5.—Tables showing Candle Power per Lamp, Watts per Candle per Lamp, and Time.

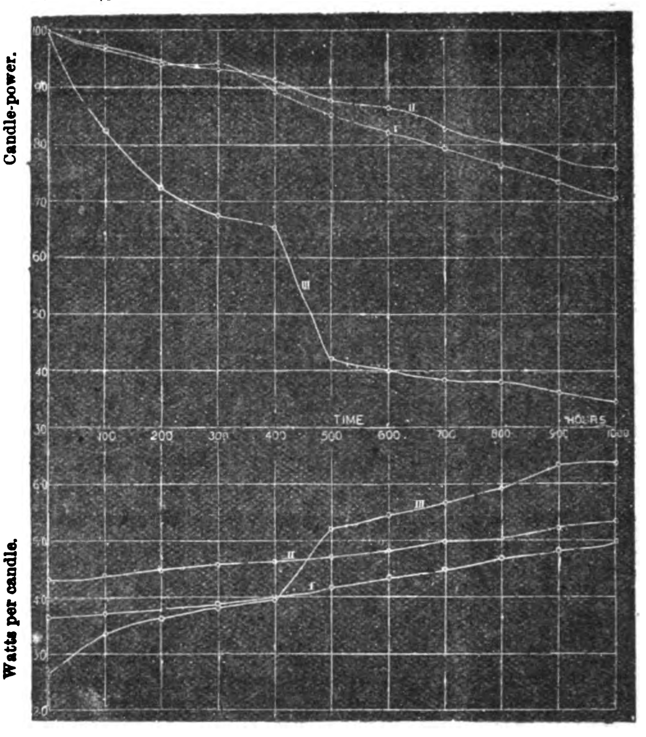
Lamps of Initial Efficiency, 3-4 Watts per Candle.

0	19	15·58	3·57	—	Out of the 19 original lamps, 12 were replaced in 1,000 hours.
100	,,	15·22	3·65	1	
200	,,	14·7	3·78	1	
300	,,	13·97	3·94	2	
400	,,	13·68	4·05	5	
500	,,	13·26	4·20	5	
600	,,	13·61	4·20	7	
700	,,	13·14	4·34	7	
800	,,	12·82	4·47	8	
900	,,	12·48	4·62	9	
1,000	,,	12·92	4·37	12	

TABLE 6.—Table showing Candle-Power per Lamp, Watts per Candle per Lamp, and Time.

Lamps of Initial Efficiency over 4 Watts per Candle.

0	14	13·43	4·50	—	In 1,000 hours two of the 14 original lamps were replaced.
100	,,	13·32	4·55	0	
200	,,	13·16	4·61	0	
300	,,	12·94	4·66	0	
400	,,	12·68	4·77	0	
500	,,	12·33	4 87	0	
600	,,	11·94	5·00	0	
700	,,	11·5	5·20	0	
800	,,	10·98	5·48	0	
900	,,	10·68	5·54	1	
1,000	,,	10·71	5·55	2	



I., for Lamps of initial watts per c.p. of 3 to 4.
II. ,, ,, ,, of over 4.
III. ,, ,, ,, of 2 to 3.

CURVES CONNECTING TIME WITH C.P. (PERCENTAGE) AND WATTS PER CANDLE RESPECTIVELY.—Sheet 1.

(*To be continued.*)

A DIRECT-READING WHEATSTONE BRIDGE.*

BY A. P. TROTTER.

In James Swinburne's "Practical Electrical Measurements" (1888), Major Cardew's "Lightning Conductor" bridge is described, and is followed by a modification arranged by Mr. Swinburne as "a simple bridge on an emergency, or for amateurs."

"An evenly-divided scale, divided into, say, 1,000 parts, is mounted as shown in Fig. 10. A uniform wire is stretched over it from the binding screw, E to N, returning by D and F to the other binding screw, H. . . . The points E, K, M, and H are fixed, because they are determined by the design of the apparatus. The problem is to find the points F and D, so that the bridge will read proportionally from M to K, and will read in ohms, or tenths, or hundredths." The mode of calibration is discussed at some length.

It is to be observed that, unlike the ordinary Kirchoff bridge, the ratio arms are H D and F D, not H F and F D. Part of the slide wire, G M, is proportional to the unknown resistance + the remainder of the slide wire. In no books to which I have access can I discover the inventor of this mode of using a Kirchoff bridge. In the old mode two readings were taken, one from each end of the scale, and a ratio was obtained from which the unknown resistance could be calculated. This is far too cumbersome for practical use. I assume that this very valuable mode is due to Major Cardew. Mr. Swinburne suggests that more than one pair of points, F and D, may be found for more than one ratio. The form of bridge which is the subject of the present paper is derived from this suggestion.

The first modification is that the wire is not in one continuous length, but is arranged as in Prof. Carey-Foster's mode of comparing two slide wires, and consists of two wires connected together at one end by a bar of negligible resistance. One of these wires constitutes the ratio arms, and the other is the slide wire. The former is concealed in the instrument. Ratio points are carefully found once for all, and branch wires are soldered at these points. Among other reasons for which the manufacture of this bridge has been placed in the hands of Messrs. Crompton and Co. is the value of the experience which that firm has acquired in accurate adjustments of this kind in the manufacture of potentiometers.

It does not appear, in Mr. Swinburne's book, that he recognised that if two separate wires and a low-resistance connecting piece be used, the zero of the scale of resistances on the slide wire is always to be found opposite the ratio point on the ratio wire. To take advantage of this disposition, the scale of the present bridge is made to slide. This is the second modification.

Ratio points 1 : 1, 1 : 5, 1 : 10, 1 : 20, and 1 : 100 are determined and the necessary branch wires are attached. The scale sliding in a groove is provided with a spring catch which holds it accurately in place, with the zero opposite to any desired ratio point. In order to avoid the idea of applying a ratio, the ratio

* Paper read before the British Association at Liverpool.

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points are described as 2, 10, 20, 40, or 200 "ohms maximum reading," the scale being divided from 0 to 20. This constitutes the third modification. The fourth modification, arising immediately from the last, is the utilisation of the spring catch for making contact between the ratio branch wire and the galvanometer. A galvanometer wire runs by the side of the slide wire, as in the Crompton potentiometer, and contact is made by the spring catch between this wire and the ratio branch wire.

The following diagram (Fig. 2) shows the connections. The whole arrangement has been reversed, in order that the scale may read from left to right. The ratio wire is divided into two parts—a and b. The ratio is not a/b, but $(a+b)/b$. The slide wire is divided by the sliding contact into two parts—e and $c+d$. The portion d is a measure of the unknown resistance x. The portion c is beyond (to the left of) the zero of the scale, and is equal to b. Then

$$\frac{a+b}{b} = \frac{x+e+d+c}{c+d}.$$

But from the construction of the apparatus $e + c + d = a + b$, and that $b = c$,

$$\therefore \frac{a+b}{b} = \frac{x+a+b}{b+d},$$

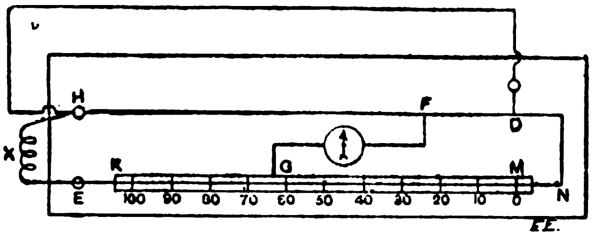

Fig. 1 (Fig. 10 reproduced from "Practical Electrical Measurements").

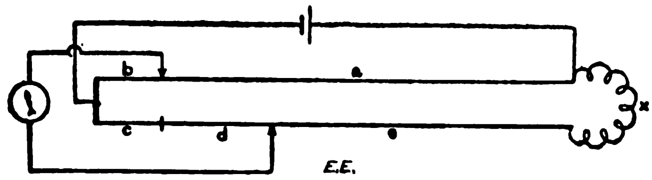

Fig 2.

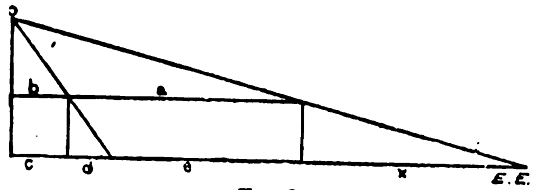

Fig. 3.

which cannot be true unless

$$\frac{a+b}{b} = \frac{x}{d},$$

or, graphically, let the line, $b\,a$, be divided into any two parts, b and a. Draw the line $c\,d\,e\,x$ parallel to $b\,a$. Complete the right-angled triangles, as shown in Fig. 3. Then $\frac{a+b}{b} = \frac{x+e+d+c}{d+c}$; and since $b = c$ and the triangles are similar, $\frac{a+b}{b} = \frac{x}{d}$. For a $\frac{1}{10}$ ratio, b is $\frac{1}{10}$ of the whole wire $a+b$, and a is $\frac{9}{10}$.

Nickel steel wire is used. The strength, hardness, freedom from corrosion, high resistance, and moderate temperature coefficient of this material make it peculiarly applicable for this purpose. It has been well tested, and has been found very suitable for potentiometers. The arrangement of the bridge as described allows the terminals to be very conveniently arranged.

The details of the instrument have been worked out by Mr. W. C. Fisher, of Messrs. Crompton and Co. The wires are 15in. long, and have a resistance of 2 ohms each. The whole instrument is 1ft. 5in. long, 2¼in. wide and 1¼in. thick, including terminals. For low resistances the scale is pulled half-way out; the maximum reading would be 2, but the two projects beyond the limits of the slider, and the highest reading is 1 ohm. One division of the scale is equal to $\frac{1}{100}$, and this may be divided by the vernier. For high resistances the scale is pulled out 0·15in., and the highest reading would be 200 ohms. This, however, projects beyond the limits, and 198·5 ohms is the highest reading. One division of the scale is equal to 1 ohm, and may be divided by the vernier.

ON A COMPLETE APPARATUS FOR THE STUDY OF THE PROPERTIES OF ELECTRIC WAVES *

BY JAGADIS CHUNDER BOSE, M.A. (CANTAB), D.SC. (LOND.), PROFESSOR OF PHYSICAL SCIENCE, PRESIDENCY COLLEGE, CALCUTTA.

The work of Herz and his eminent successors, both here and in the Continent, has opened out for study a new region of ethereal vibration, bridging over the gap that hitherto existed between the comparatively slow electric vibrations and the quick oscillations which give rise to radiant heat. In the vast range of possible ether vibrations we recognise only a few octaves by our senses; the rest are beyond our perception. Many unexpected properties of these little-known ether waves are now being gradually discovered. Confining our attention to the electric waves, we find that there are many important problems which may perhaps be better attacked with these comparatively slow ether vibrations, among which may be mentioned the determination of the indices of refraction of various substances which are opaque to visible light, but are transparent to the electric ray; the relation between the dielectric constant and the refractive index when the rates of oscillation are made comparable in the two determinations—the variation of the index with the frequencies of vibration. Then there are the phenomena of double refraction, polarisation, and the magnetic rotation of the electric ray, the determination of the wave-length, and other problems of a similar nature. The fascination of the subject drew me to its study, though the investigations were rendered exceedingly difficult in India from want of facility for making the necessary instruments. I ultimately succeeded in constructing a few instruments, with which I was able to obtain the values of the indices of refraction of various substances for electric waves, the wave-length of electric radiation, and to demonstrate the phenomena of double refraction and polarisation of the electric rays. Before you is the simplified apparatus with which many of the properties of electromagnetic radiation may be studied. This is a duplicate made by Messrs. Elliott Bros. of the somewhat rudely-constructed apparatus which I brought from India. I also take this opportunity of thanking Mr. Bolton, F.R.A.S., of the Mathematical Instrument Department, Calcutta, for the divided circle in my apparatus. The following are the experiments which may be carried out with this apparatus: A.—Verification of the laws of reflection: (1) Plane mirrors; (2) curved mirrors. B.—Phenomena of refraction: (1) Prisms; (2) total reflection; (3) opacity caused by multiple refraction and reflection; (4) determination of the indices of refraction. C.—Selective absorption: (1) Electrically-coloured media. D.—Phenomena of interference. E.—Double refraction and polarisation: (1) Polarising gratings; (2) polarising crystals; (3) double refraction produced by crystals; (4) double refraction produced by other substances; (5) double refraction produced by strain; (6) circular polarisation; (7) magnetic rotation; (8) electro-polariscope and polarimeter. In the list of experiments above mentioned, the determination of wave-length by curved gratings has been carried out with a larger apparatus (see the current number of the *Proceedings*, Royal Society). Experiments with circular polarisation and magnetic rotation are still in progress. All the others have been repeated with the apparatus to be described below. The complete apparatus consists of—(1) a radiating apparatus emitting electric waves of short length; (2) a receiver used as a detector of electric radiation; and (3) various accessories for the study of the different phenomena.

Radiating Apparatus.

Electric oscillation is produced by sparking between two beads of platinum and an interposed sphere of the same metal. The discharge ceases to be oscillatory when the ball is roughened, and a platinum ball resists, to a great extent, the disintegrating action of the sparks. Two jointed electrodes carry the two beads at their ends. The distance between the beads and the interposed sphere can thus be adjusted. This is a matter of importance, as the receiver does not properly respond if the spark length is too large. It is more convenient to use short electric waves, and this is obtained by making the radiating spheres very small. The shortest wave-length produced is about 6mm., and the corresponding number of oscillations is about 50,000 millions in a second. The frequency of vibration in this case will be seen to be about 13 octaves lower than that which produces visible radiation. The intensity of radiation in the above case is rather feeble, and I use in general electric waves of about ½in. in length. The jointed electrodes carrying the beads are in connection with a small modified Ruhmkorff coil, actuated by a small storage cell. The usual vibrating interrupter is a source of trouble; the contact points get worn out, and the break becomes irregular. I have, therefore, discarded it in favour of a simple interrupting key. The great objection to the continuous production of

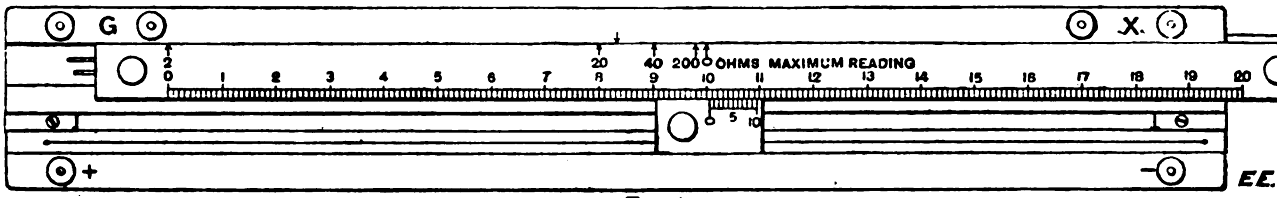

Fig. 4.

* Paper read before the British Association at Liverpool.

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secondary sparks is the roughening of the surface of the radiating ball, by which the spark ceases to be oscillatory. It is very troublesome to be obliged to take out the radiator, in the middle of an experiment, for polishing. The flash of radiation produced by a single break is enough for an experiment, and it is a mere waste to have a series of useless oscillations. To economise space, I wind the condenser (a long strip of paraffined paper with tinfoil on opposite sides) round the secondary of the coil, appropriate connections being made with the interrupting key. The coil and a small storage cell are enclosed in a tinned iron box. Iron is used to screen the space outside from magnetic disturbance due to the making or breaking of primary circuit of the coil. A sudden magnetic variation disturbs the receiver. The iron box is placed inside a second box of thick brass or copper. These precautions are taken to prevent straying of electric radiation. Through a small opening behind the box the stud of the press key projects. In front of the box is the radiator tube, which may be square or cylindrical. Inside this tube is mounted the radiating vibrator. A flash of electric radiation is produced by proper manipulation of the interrupting key. The radiating apparatus may thus be made very small and portable, and requires very little attention. After the storage cell is once charged, experiments may be carried on for days, a flash of radiation being produced at any time by merely manipulating the key.

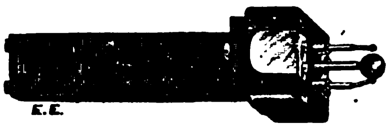


Fig. 1.—The Radiator.

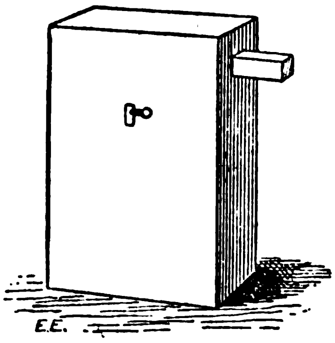


Fig. 2.—The Radiating Box.

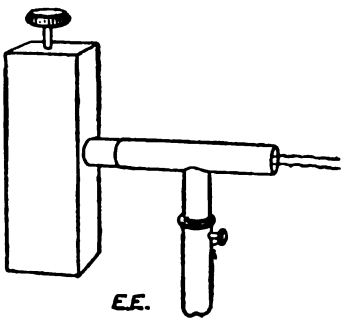


Fig. 3.—The Spiral Spring Receiver.

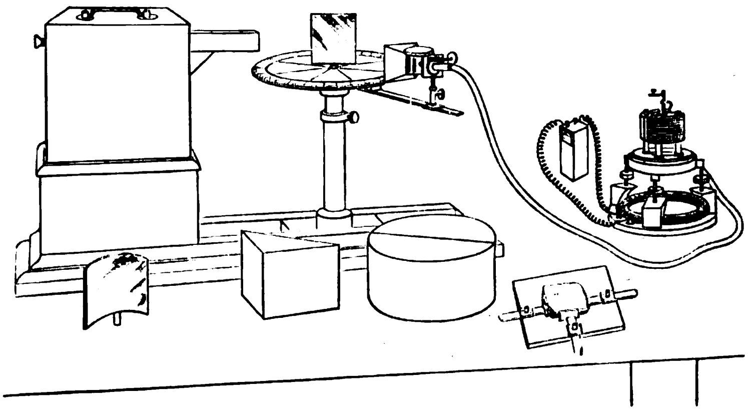


Fig. 4.—Arrangement of the Apparatus.

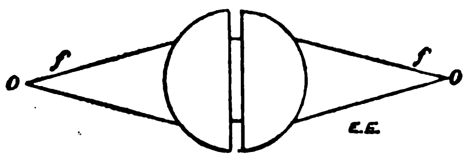
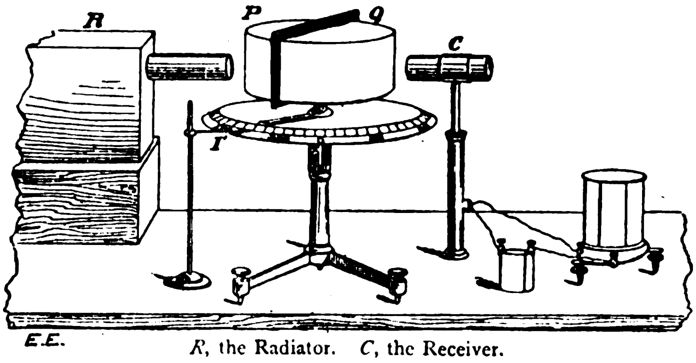


Fig. 5.



R, the Radiator. *C*, the Receiver.
Fig. 7.

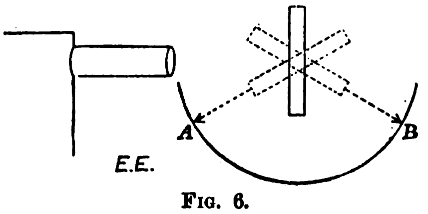


Fig. 6.

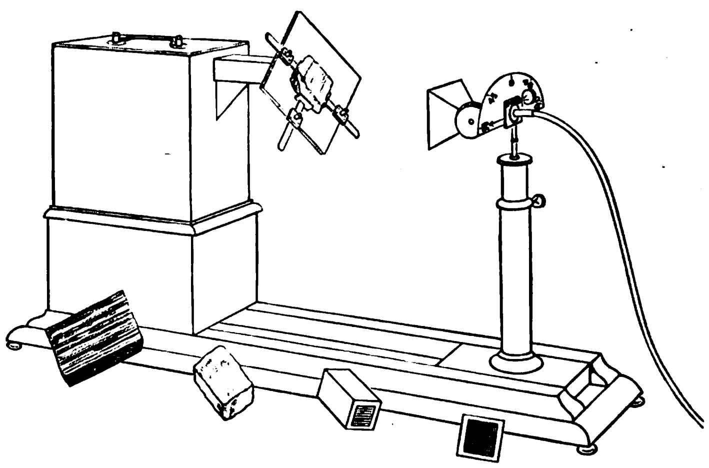


Fig. 8.—Polarisation Apparatus.

SPIRAL SPRING RECEIVER.

The receiving circuit consists of a spiral spring coherer, in series with a voltaic cell and a dead-beat galvanometer. The receiver is made by cutting a narrow groove in a rectangular piece of ebonite, and filling the groove with bits of coiled steel springs arranged side by side in a single layer. The spirals are prevented from falling by a glass slide in front. The spirals are placed between two pieces of brass, of which the upper one is sliding and the lower one fixed. These two pieces are in connection with two projecting metallic rods which serve as electrodes. An electric current enters along the breadth of the top spiral and leaves by the lowest spiral, having to traverse the intermediate spirals along the numerous points of contact. The resistance of the receiving circuit is thus almost entirely concentrated at the sensitive contact surface, there being little useless short-circuiting by the mass of the conducting layer. When electric radiation is absorbed by the sensitive surface, there is a sudden diminution of the resistance, and the galvanometer spot is violently deflected. By means of a very fine screw the upper sliding piece can be gently pushed in or out. In this way the spirals may be very gradually compressed, and the resistance of the receiver diminished. The galvanometer spot can thus be easily brought to any convenient position of the scale. When electric radiation falls on the sensitive surface the spot is deflected. By a slight unscrewing the resistance is increased, and the spot made to return to its old position. The receiver is thus re-sensitised for the next experiment. The sensitiveness of the receiver may be increased by a proper adjustment of the E.M.F. acting on the receiving circuit. The receiver at each particular adjustment responds best to a definite range of vibration lying within about an octave. The same receiver could,

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however, be made to respond to a different range by an appropriate change of the E.M.F. ; very careful adjustment of this is necessary to make the receiver respond at its best to a particular range of electric vibration. For simple experiments the adjustment of the receiver is not difficult, but for delicate experiments careful manipulation is necessary. The proper adjustment of the E.M.F. is effected by taking a derived current from a circular potentiometer slide, fixed at the base of the galvanometer. A simpler way is to take a U tube, the two limbs being respectively filled with copper sulphate solution and dilute sulphuric acid. Mixture of the two solutions is prevented by an interposed plug of asbestos. A rod of copper and a rod of zinc are plunged in the two electrolytes, the whole forming a modified Daniell cell. The cell is shunted by a suitable resistance, the receiving circuit being connected to the ends of the shunt. The current flowing through the shunt, and therefore the derived E.M.F. from its ends, is varied by plunging the rods more or less in the solutions. The leading wires from the ends of the receiver are enclosed in layers of tinfoil ; the galvanometer and cell have a metallic cover with a slit for the passage of reflected spot of light. The receiving circuit is thus shielded from the disturbing action due to stray radiations. The receiver is provided with a collecting funnel. This prevents lateral waves from acting on the receiver. The funnel has two hinged side-doors by which its area—and, therefore, the amount of radiation collected—may be varied. When angular deviation is to be measured, the doors are made parallel and perpendicular to the layer of spirals. The aperture is reduced, and the receiver then only responds when the funnel points to the direction of the deviated ray. In polarisation experiments it is necessary to adjust the receiver carrying the analyser in a crossed position. This is done by a tangent screw, the rotation of the analyser being measured by means of an index and a graduated vertical disc.

Arrangement of the Apparatus.

The radiating apparatus and the receiver are mounted on stands sliding in an optical bench. Experiments are carried out with divergent or parallel beam of electric radiation. To obtain a parallel beam a cylindrical lens of sulphur or ebonite is mounted in a square tube. This lens tube fits on the radiator tube, and is stoped by a guide when the oscillatory spark is at the principal focal line of the lens. The radiator tube is further provided with a series of diaphragms by which the amount of radiation may be varied. For experiments requiring angular measurement, a spectrometer circle is mounted on one of the sliding stands. The spectrometer carries a circular platform on which the various reflectors, refractors, etc., are placed. The platform carries an index, and can rotate independently of the circle on which it is mounted. The receiver is carried on a radial arm (provided with an index) and points to the centre of the circle. An observing telescope may also be used with an objective made of ebonite with a linear receiver at the focal plane. But an ordinary receiver provided with a funnel is all that is necessary for ordinary experiments.

Laws of Reflection.

Plane Mirrors.—A parallel beam is used. The spectrometer circle is adjusted with the zero division opposite to the radiator. The platform index is turned to zero, and a plane reflector placed on a previously marked diameter at right angles to the index. The receiver is placed, say, at 60deg. The platform carrying the mirror is slowly rotated (electric radiation being at the same time produced by tapping the key) till the receiver suddenly responds. It would now be found that the platform index points to 30deg., midway between the radiator and the receiver.

Curved Mirror.—A cylindrical metallic mirror, with a radius of 25cm., is placed on the platform, with its principal axis coinciding with the platform index. When the radiator is placed at a distance of 25cm. from the mirror the source of radiation would be at the centre of the cylinder. The reflected image will now be formed at an equal distance. The receiver mounted on the radial arm (at a distance of 25cm. from the centre) is placed at a given angle; the platform is rotated till the receiver responds. The index would now be found to bisect the angle included between the radiator and the receiver.

Refraction.

Deviation of the Electric Ray by a Prism.—An isosceles right-angled prism is made of sulphur or ebonite. Parallel beam is used. For showing deviation by refraction one of the acute angles is interposed on the path of the beam.

Total Reflection.—An interesting experiment on total reflection is shown in the following way : The receiver is placed opposite to the radiator, and the prism interposed with one of its equal faces at right angles to the direction of the ray. The receiver will remain unaffected. The critical angle of ebonite being considerably less than 45deg., the rays undergo total reflection. On turning through 90deg. the receiver responds to the totally eflected ray.

Opacity due to Multiple Refraction and Reflection.—An experiment analogous to the opacity of powdered glass to light is shown by filling a long trough with irregular-shaped pieces of pitch and interposing it between the radiator and the receiver. The electric ray is unable to pass through the heterogeneous media owing to the multiplicity of refractions and irregular reflections, and the receiver remains unaffected ; but on restoring partial homogeneity by pouring in kerosine, which has about the same refractive power as that of pitch, the radiation is easily transmitted.

Determination of the Indices of Refraction.—Two semi-cylinders of the given substance separated by an air film is placed on the platform. When the radiator is placed at the principal focus of one of the semi-cylinders the rays emerge parallel into the air film, and are then focussed on the receiver by the second semi-cylinder. A metallic plate with a narrow rectangular opening is interposed between the semi-cylinders to serve as a diaphragm, and cut off all but the central rays. As the platform is rotated the incident angle on the plane surface separating the two media is gradually increased till the rays undergo total reflection When this is the case the receiver ceases to respond. The index reading is now taken, and the cylinders rotated in an opposite direction till total reflection takes place a second time. The difference of readings as given by the index in the two positions is evidently equal to twice the critical angle. Hence the value of the index can easily be deduced. A preliminary experiment gives the approximate value of the index, from which the focal distance of the semi-cylinder is roughly calculated. The spark gap of the radiator is placed at this focus, and the experiment repeated. In this way I have determined the indices of refraction of several solids for the electric ray (*vide Proceedings* of the Royal Society, vol. lix). The index of refraction of commercial sulphur is = 1·73; that of a specimen of pitch = 1·48

Indices for Liquids.—A cylindrical trough is filled up with the given liquid ; two thin parallel glass plates enclosing an air film are vertically placed so as to divide the liquid cylinder into two halves. The readings for total reflection are taken as in the last case. The index for coal tar I found to be 1·32.

Selective Absorption.

A substance is said to be coloured when it allows light of one kind to pass through but absorbs light of a different kind If we take into account the entire range of radiation there is hardly a substance which is not in this sense coloured. In the spectrum of radiation transmitted through glass for example, two broad absorption bands would be observed, one in the ultra-violet and the other in the infra-red, the electric and the visible rays being not absorbed to any great extent. A brick or block of pitch would absorb light, but would transmit the electric ray. On the other hand, a stratum of water, though transparent to light, would absorb the electric ray. These substances exhibit selective absorption, and are therefore coloured. If we only take into account the electric radiation it would no doubt be found that radiations having different wave-lengths are unequally absorbed by different substances.

Phenomena of Interference.

Determination of the Wave-Lengths by Diffraction Grating.—In a paper read before the Royal Society in June last I have given an account of a method of obtaining pure spectra of electric radiation by means of a curved grating. The experiment was carried out with a large apparatus. The spectrum obtained was well defined, and appeared to be linear, and not continuous. I had not time to adapt the experiment to this small apparatus, but I think it would not be difficult to do so.

Double Refraction and Polarisation.

The spectrometer circle is removed, and an ordinary stand for mounting the receiver substituted. By fitting the lens tube, the electric beam is made parallel. At the end of the lens tube there is a slot, in which is dropped the wire grating polariser. A crystal-holder provided with three sliding jaws is fitted on to the lens tube, and is capable of rotation round an axis parallel to the direction of the electric ray. The receiver carrying the analyser is also capable of rotation round a horizontal axis by means of a tangent screw. The angular rotation is measured by means of an index fixed to the analyser and a graduated vertical disc. The gratings are made by winding fine copper wire parallel round square frames. Other forms of polariser will be described later on. The spark gap is placed vertical, and the polariser is adjusted with wires horizontal. The emergent beam is now completely polarised, the vibration taking place in a vertical plane passing through the axis. The analyser fitted on to the receiver may be placed in two positions: (1) parallel position—when both the gratings are horizontal ; (2) crossed position—when the polarising grating is horizontal and the analysing grating vertical. In the first position, the radiation being transmitted through both the gratings, falls on the sensitive surface, and the galvanometer responds. The field is then said to be bright. In the second position the radiation is extinguished by the crossed gratings, the galvanometer remains unaffected, and the field is said to be dark. But on interposing certain crystals with their principal planes inclined at 45deg. to the horizon the field is partially restored, and the galvanometer spot sweeps across the scale. This is the so-called depolarisation action of double-refracting substances.*

Experiments with Wire Gratings.—A wire grating at 45deg. interposed between the crossed analyser and polariser partially restores the field, but ordinary wire gauze does not transmit any radiation, the action of one set of wires being neutralised by that of the other set at right angles.

Double Refraction Produced by Crystals.—The crystals to be examined are mounted on the holder, and properly inclined. Double refraction is shown by all crystals belonging to the rhombic, rhombohedral, triclinic, and monoclinic systems. The effects exhibited by the following are very marked : (1) Serpentine : This crystal, which appears fibrous, transmits the ordinary and the extraordinary rays with unequal intensity. A fairly thick piece would absorb vibrations

* For a detailed account of experiments on the polarisation of the electric ray, I would refer to my paper read before the Asiatic Society of Bengal, May, 1895.

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parallel to the fibres, and transmit vibrations perpendicular to the fibres. Ordinary radiation, after transmission through a thick piece of serpentine, would be plane polarised, the vibration taking place perpendicular to the fibres. (2) Nemalite: This crystal exhibits this effect in a still more marked degree. (3) Tourmaline also produces the depolarisation effect. The difference in absorption of the ordinary and the extraordinary rays is, however, not so great as in the case of light. (4) Beryl is also very good crystal for exhibiting the depolarisation effect.

Polarisation Produced by other Substances.—I found many other natural substances producing polarisation, the most interesting being vegetable fibres. Common jute (*Corchorus capsularis*) exhibits the property in a very marked degree. I cut fibres of this material about 3cm. in length, and built with it a cell with all the fibres parallel. I subjected this cell to a strong pressure under a press. I thus obtained a compact cell 3cm. by 3cm. in area and about 5c.m. in thickness. This was mounted in a metallic case, with two openings about 2cm. by 2cm. on opposite sides for the passage of the radiation. This cell was found to quench vibrations parallel to the fibres, and transmit vibrations perpendicular to the fibres. Jute cells could thus be made to serve as polarisers or analysers.

Effect Due to Strain.- Could be exhibited by stratified rocks, the plane of stratification being inclined at 45deg. to the horizon.

Effects similar to that produced by unannealed glass can be imitated by a block of unequally chilled paraffin.

The polarisation apparatus above described may also be used as a polarimeter, the rotation of the analyser being measured by the graduated disc.

COMPANIES' MEETINGS AND REPORTS.

WILLANS AND ROBINSON, LIMITED.

The fifth half-yearly report of the directors of this Company for the period ended June 26, to be submitted at the general meeting to be held at the Cannon-street Hotel on October 7, states that, after writing off depreciation from plant, patents, etc., the sum of £4,040, and paying a small amount of interest accrued upon the recently-issued debenture stock, the balance to the credit of profit and loss account for the half-year (including £821 brought forward) is £12,877. Out of this the directors propose that dividends be paid at the full rate of 6 per cent. per annum on the preference shares, and at 7 per cent. per annum, as before, upon the ordinary shares, together taking £7,312. The amount payable to the directors, in accordance with the articles of association, is £1,423, and it is proposed to carry £2,500 to the reserve fund, raising the amount to £10,146 as the result of 2½ years' working. The balance, £1,641, it is proposed to carry forward. The debenture stock authorised to be created by the resolution passed at the last general meeting was issued in May, at par, the rate of interest being 4½ per cent. per annum, and was largely over-subscribed. The directors were advised to fix the issue at £100,000, rather than at the smaller amount they had in view at the date of the last meeting. The growth of the business in the present year leaves no doubt that the larger amount can be utilised with advantage. The expenses connected with the above issue amounted to £1,151, which sum appears on the present occasion as a credit in the balance-sheet. As the debenture stock is repayable after a term of years, it would be proper to write off the expenses by a small half-yearly charge extending over the same term; but it will probably be felt that so small a sum ought to be dealt with immediately, as, for instance, by writing it off at once out of the balance to be carried forward in the profit and loss account. To this it may be objected that the balance in question is surplus profit, and therefore has already contributed to the contingent salaries of the directors and staff, whereas, strictly, the cost of the debenture issue is in the nature of an expense, which should reduce the surplus profits, and therefore the contingent salaries. If, on the other hand, the amount is written off at once, and the contingent salaries are reduced in proportion, it will fall somewhat hardly upon the present holders of office, who will bear a charge which ought partly to fall upon their successors. It is not urgent that the question be settled upon the present occasion, and, as the directors' own interests are involved, they trust to receive some expression of opinion on the part of the shareholders, as a basis for action to be taken next half-year. The Company's shares were granted a quotation by the committee of the Stock Exchange last May, and a quotation of the debenture stock (provisional certificates) has since been given. The works of the Company continue to be very fully employed; in fact, orders are in hand for a long period in advance. Work will shortly be commenced in the new shops at Rugby. The report is signed by the chairman, Mr. Mark Robinson.

BRUSH ELECTRICAL ENGINEERING COMPANY, LIMITED.

Directors: J. B. Braithwaite, jun., Esq. (of Messrs. Foster and Braithwaite), chairman; Arthur Ayres, Esq., M.I.C.E; Aymor H. Sanderson, Esq.; Colonel Frederick George Steuart; B. H. Van Tromp, Esq.; Edward Woods, Esq. (past-president Institution of Civil Engineers). Joint managers: John S. Raworth, M.I.C.E.; R. Percy Sellon, M.I.E.E.

The seventh annual report of the directors, to be presented to the shareholders at the general meeting of the Company to be held at Cannon-street Hotel, London, E.C., on Monday, October 5, at 12 o'clock noon, states that the profit and loss account shows a gross profit of £33,736. After deducting general charges, maintenance of buildings, plant, and patents, staff bonuses under the Company's profit-sharing scheme, bank interest, and interest on first and second debenture stock, there remains a net balance of profit for the year of £4,615. The directors regret that the profits for the year are not larger. The result is attributable partly to a general falling off in the volume of central-station electricity supply contracts and partly to the prevalence of unduly low prices for electrical machinery. The directors anticipate, however, that the future demand for electric traction plant will fully compensate for the shrinkage of orders for electric lighting machinery, while with regard to prices they are glad to state that there are some indications of improvement. Meanwhile, every effort has been made to minimise general and administrative charges, there having been the substantial reduction of nearly £4,000 which has been effected during the year. The directors anticipate still further reductions during the current year. During the past year the directors have accepted an offer from one of the large Continental manufacturing firms for the purchase of the Vienna factory. The amount realised fully reimburses the Company for its capital outlay on the business, and the sum resulting from the transaction, which was upon a cash basis, appears under the items relating to cash in the balance-sheet. In deference to the wish expressed by shareholders at recent annual general meetings, and, in view of the disposal during the year of the Company's Vienna factory, the directors consider the present a convenient opportunity for sub-dividing the capital item of property, patents, and goodwill, which has hitherto appeared as a single item in the balance-sheets. With this object they have obtained a full report from Messrs Fuller, Horsey, Sons, and Cassell, whose valuation of the Company's freehold works, together with the fixed plant, machinery, loose tools, and utensils, at Loughborough, Leicestershire, amounts to £83,847, and of the leasehold factories at Lambeth and Southwark, to £5,000, together value £88,847. Deducting this sum from the amount of £295,244, representing the agregate value of the undivided items of property, patents, and goodwill, it will be seen that a balance of £206,397 is represented by patents and goodwill. While many valuable patents owned by the Company are still included in the item of patents, the early patents in connection with electric lighting, for which large sums were originally paid by the Company, have now mostly expired. In order to deal effectively with the position thus arising, the directors strongly recommend the shareholders to write off £1 per share from the nominal value of the ordinary shares of the Company. This will produce a figure of £90,000, which it is proposed to apply during the current year to reduction of the item of patents and goodwill, and to eliminating from the books such of the items included in the suspense account appearing in the balance-sheet as may prove to be valueless. The directors have placed to this suspense account all assets standing in the books of the Company which they consider to be in any way doubtful; and the step now recommended, upon receiving the sanction of the shareholders, will ensure that profits of future years shall not be hampered by the uncertainty attaching to the doubtful assets referred to. A resolution to carry out this recommendation will be submitted to an extraordinary general meeting to be held at the close of the ordinary meeting. Subject to this recommendation being adopted by the shareholders, the directors propose to pay to the preference shareholders the balance of dividend due to them from last year, amounting to £2,141, and to carry forward the balance of £1,654 which remains after clearing off the debit of £820 brought forward from last year. In accordance with the shareholders' approval at the last annual general meeting of the decision to create an issue of £105,000 4½ per cent. redeemable second debenture stock, £76,770 of such stock was allotted in the autumn of last year. During the year under review the Company have sub-leased the Lambeth factory for the remainder of their term; and have transferred the final remnant of their London manufacturing operations to Loughborough, where the whole of the Company's manufacturing is now concentrated. An important contract has been secured from the British Electric Traction Company for the equipment of the North Staffordshire tramways system with electric traction. There is every indication that electric traction will be largely adopted in this country in the immediate future; and the position of the Company in regard to the undertaking of works of this character is exceptionally favourable, having regard to their command of ample working capital, and to the fact of their being manufacturers of rolling-stock and tramway material as well as of electrical plant. The contracts with the County of London and Brush Provincial Electrical Lighting Company for the equipment of electricity supply stations in St. Luke's, Middlesex, and the Wandsworth district have been in progress during the year, and it is expected that a supply of current will be available in both areas during the coming winter. The contract with the Government of Malta for the establishment of an electricity supply station for the lighting of Valetta and of the Government establishments is now practically completed, and the result has given general satisfaction. During the year the "Universal" steam-engine, to which the attention of shareholders was drawn last year, has been developed, tested, and placed upon the market. Orders are in course of execution for central electricity supply stations, factories, mining works, etc. The Company are introducing a type of alternating-current dynamo, new to this country, for which they hold important patent rights. This dynamo possesses valuable features which the directors believe are likely to command for it a ready sale. The following is the balance-sheet of the Company:

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BALANCE-SHEET, JUNE 30, 1896.

Dr.	£	s.	d.	£	s.	d.
Authorised capital	750,000	0	0			
Capital issued—viz., 90,000 6 per cent preference shares of £2 each, £180,000; and 90,000 ordinary shares of £3 each, £270,000				450,000	0	0
4½ per cent. perpetual first debenture stock				125,000	0	0
4½ per cent redeemable second debenture stock ...				76,770	0	0
Creditors—Sundry creditors, £28,982. 16s. 2d.; bills payable, £4,602. 18s.				33,585	14	2
Loan from bankers				26,775	0	0
Balance of profit and loss account, subject to realising the whole of the suspense account, *per contra*	4,615	9	8			
Less balance as per last account	820	7	4			
				3,795	2	4
				£715,925	16	6

Note.—Contingent liability in respect of uncalled capital on shares in other companies, £11,142. 10s.

Cr.	£	s.	d.	£	s.	d.
Property — factories at Loughborough, Lambeth, and Southwark	88,847	0	0			
Patents and goodwill	206,397	8	9			
				295,244	8	9
Stock	124,031	8	2			
Less amounts transferred to suspense account	23,368	11	9			
				100,662	16	5
Debtors	140,433	7	8			
Less amounts transferred to suspense account	24,158	6	2			
	116,275	1	6			
Bills receivable.........	1,235	13	10			
				117,510	15	4
Cash at bankers, in hand, and instalment on account of sale of Vienna factory....................				28,714	0	9
Balance on account of sale of Vienna factory, payable October 1, 1896				61,900	0	9
Shares and debentures in other companies (at cost)	64,366	16	7			
Less amounts transferred to suspense account	7,912	10	0			
				56,454	6	7
Suspense account, consisting of amounts transferred from stock, debtors, and shares and debentures in other companies :						
Transferred from stock	23,368	11	9			
Transferred from debtors	24,158	6	2			
Transferred from shares and debentures in other companies	7,912	10	0			
				55,439	7	11
				£715,925	16	6

The auditors, Messrs. Cooper Bros. and Co., append the following note:

"We have examined the above balance-sheet with the books, accounts, and vouchers of the Company, and in our opinion, subject to the following remarks, it is properly drawn up so as to exhibit a correct view of the Company's affairs on June 30, 1896. We have verified the cash balances and the shares and debentures in other companies. The latter are considered by the Board to be of the full value stated in the accounts, but as to a part of them we are not able to verify the market value. It will be noticed from the directors' report that the assets transferred to the suspense account are considered doubtful, and we have not means of ascertaining their value. We have also verified the securities held by the trustees of the employés bonus scheme."

APPROPRIATION ACCOUNT.

(Subject to adoption by the shareholders of the recommendation of the directors to reduce the nominal value of the ordinary shares by £1 per share.)

Dr.	£	s.	d.
Balance of dividend due to preference shareholders for year ended June 30, 1895	2,141	3	8
Balance carried forward	1,653	18	8
	£3,795	2	4
Cr.	£	s.	d.
Balance	3,795	2	4
	£3,795	2	4

A summary of the profit and loss account is given at the beginning of the directors' report. On the credit side the only items besides gross profits are dividends on securities £330 odd, and transfer fees £107. On the debtor side maintenance of buildings and plant cost £3,048.

The Blackwall Tunnel.—The passage from end to end has now been opened through, and a small party of about 12 went through it for the first time on Wednesday. The electric lighting plant has been ordered.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Dresden.—Tenders for 3,710 wooden telegraph posts for the Saxon State Railways are receivable at Dresden on October 15.

Bucharest.—Tenders will be received at the Mairie, Bucharest, on November 16 for two stand-by steam-engines for a water-power electric generating station at Grozavesti.

Aarhus (Denmark).—Tenders will be received on October 8 by the State Railway Administration at Aarhus (Telegraphen sections Contoir) for the supply of a large quantity of sulphate of copper.

Leyton.—Tenders will be received by the Urban District Council on October 6th for installing the electric light in the public library. Particulars are obtainable at the surveyor's office, Town Hall, Leyton.

Madrid.—Tenders will be received on October 12 by the Direccion General de Correos y Telegrafos at Madrid for the supply to the Spanish Government of 60,000 telegraph insulators. The upset price is 1 peseta (9½d.), and a 10 per cent. security will be required.

Villefranche-Lauragais (France).—The Municipality of Villefranche-Lauragais (Haute-Garonne) have invited competitive plans for a public water supply and electric lighting. Prizes of 1,000fr., 500fr., and 200fr. are offered, under the usual conditions, and schemes must be sent to the Mairie by October 10.

Paris.—The French Telegraphic Authorities have offered for tender the supply and laying of a four-wire submarine telephone cable between France and England. The date for sending in tenders is October 20, but application for permission to tender must be made before October 5 to the Under Secretariate of Posts and Telegraphs, Paris, rue de Grenelle 103.

Brussels.—Tenders will be received on October 21 for the supply to the Belgian telegraphic service of (1) a quantity of galvanised iron wire, (2) various lengths of cable for riverine, submarine, and land service, and (3) a quantity of bare and insulated copper wire. No details are advertised as to the amounts required, but particulars are obtainable at the Brussels Bourse.

Werl (Germany).—The Local Authorities propose to submit to tender the construction and maintenance of an electric power and lighting generating station, and also an electric tramway from Werl to Wikede, with an eventual extension to Hamm. Further particulars will be obtainable at the Rathhaus, Werl-i.-Westf., Germany. The date for the tenders is November 3.

Paris.—Tenders will be received on October 13, at the Under Secretariate of Posts and Telegraphs, Paris, rue de Grenelle 103, for the supply of about 70 tons of 2½ millimetre galvanised iron wire (special), 50 tons ordinary galvanised wire (5mm.), and 100 tons of 7mm. wire; also a quantity of jute wrapping. Application for permission to tender must be made by October 6.

Cologne.—Tenders are required by the Municipal Authorities for the construction and working of electric tramways in the city of Cologne to an aggregate length of 20·3 kilometres (12½ miles). Specifications, plans, and particulars are obtainable for 10 marks (10s.) from der Registrateur B, des Oberbürgermeisteramt, Köln, Germany, and tenders must be in by November 6.

Madras.—Tenders are invited for the lighting by electricity of Government House, Madras, including the banqueting-hall and aide-de-camps' bungalow, and also for the lighting of Government House, Guindy, including the military secretary's bungalow. For particulars application must be made to the consulting architect to the Government, Chepank, Madras. Tenders will be opened on November 11, 1896.

Mayaguez (Puerto Rico).—The Secretary of State for Foreign Affairs has been informed by H.M. Ambassador at Madrid that the Spanish Government have invited tenders for the construction and working of a telephone system in Mayagüez, Puerto Rico. The date fixed for the consideration of tenders is October 8, and such particulars as have been received may be inspected at the Commercial Department of the Foreign Office between the hours of 11 and 6 daily.

Brussels.—Tenders will be received on October 21, at the Bourse, Brussels, for installing the electric light at the Arlon Railway Station, including the offices and works. Particulars are obtainable at the Brussels Bourse. La Société national des chemins de fer vicinaux will receive tenders up to October 28 for the conversion of about 14½ miles of tramway in the suburbs of Charleroi into electric lines on the overhead system. Particulars are obtainable, price 1fr., from the office of the Société, Brussels, rue de la Science 26.

Leeds.—The Council require tenders for the supply and erection of No. 2 overhead travelling cranes for the engine-house of the tramways electricity generating station, The Calls, Leeds. Tenders, endorsed "Tender No. 8 for Cranes," must be sent in, addressed to the Town Clerk, Town Hall, Leeds, not later than 12 noon on October 13. Particulars, plans, and forms of tender may be had from the City Engineer, Municipal Buildings, Leeds, or from Dr. John Hopkinson, F.R.S., 5, Victoria-street, Westminster, S.W.

Madrid.—The Secretary of State for Foreign Affairs has received a despatch from H.M. Chargé d'Affaires at Madrid stating that a free public competition is announced in the *Gaceta de Madrid* of September 4 for the grant of the contract for the construction and

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establishment of three submarine cables to join the islands of Luzon, Panay, Negros y Cebu, in the Philippine Archipelago. Tenders must be lodged within 90 days of the publication of the conditions at the Spanish Ministry of the Colonies, accompanied by a deposit of 50,000 pesetas. The particulars received can be seen at the Commercial Department of the Foreign Office between the hours of 11 and 6.

Dundee.—Tenders are invited for boiler, fittings, steam pump and piping, wiring, fittings, accumulator batteries, steam and oil engines and dynamos, for the electric lighting of the Dundee Royal Lunatic Asylum. Sealed tenders to be sent to the secretary, Mr. Robert C. Walker, 5, Whitehall-street, Dundee, endorsed outside "Electric Lighting Tenders," by noon on October 9. Specifications and forms of tender may be obtained from the Engineer on deposit of £1. 1s., which will be returned on receipt of bona fide tenders. Plans, etc., may be seen on application to Mr. Walter H. Tittensor, electrical engineer, Dudhope, Crescent-road, Dundee. No copies will be supplied.

Christiania.—The Secretary of State for Foreign Affairs has received a despatch from her Majesty's Consul-General at Christiania stating that tenders are invited for the delivery of 22,000 linear metres (13 miles 1,180 yards) of rails, with the accompanying fishplates and screws, for the electric tramline to be constructed between Christiania and Holmenkollen. Tenders are to be sent in sealed envelopes, marked "Aubud," by October 15, 1896, to the Tramline's Offices, 47, Kirkeveien, Christiania, where the conditions can be procured. The rails must be delivered in Christiania by January 1, 1897. Further particulars on the subject are expected from her Majesty's Consul-General, and will be on view as soon as they have arrived at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 6 p.m.

Morley.—The Electric Lighting Committee of the borough of Morley are prepared to receive tenders for the supply and erection of the following plant. (The whole bound up in one specification; price £2. 2s., returnable on receipt of a bona fide tender): Section A—Boiler-house plant: Lancashire boilers and fittings, feed pump, etc. Section B—Engine-house plant: steam alternators and exciters, motor alternator, accumulators, steam and exhaust pipes, valves, etc. Section C—switchboard and instruments. Section D—overhead crane. Section E—underground work: cables and stoneware culverts. Section F—transformers and switchboards. Section G—arc lamps, posts, and accessories. Section H—meters. Tenderers are at liberty to tender for any section, but not for part of a section. The ground plans of plant and specification, with terms and conditions of tenders and contract, may be obtained at the offices of Mr. Robert Hammond, the consulting engineer, Ormond House, Great Trinity-lane, London, E.C., on payment of £2. 2s. for each copy, which sum will be refunded on the return of the specification, filled up with a bona fide tender. Tenders, sealed and marked "Tender for Electric Lighting," must be addressed to the town clerk, Mr. R. Borrough Hopkins, at the Town Hall, Morley (Yorks), and be delivered on or before Wednesday, October 14.

BUSINESS NOTES.

Metropolitan Electric Supply Company, Limited. —The directors have declared an interim dividend of 4s. per share for the half-year.

Bridlington Quay.—Messrs Whittaker Bros., of Horsforth, propose to build a large hotel, which is to be fitted throughout with electric light

Liverpool.—The Lighting Committee of the Corporation have decided to recommend a scheme for the electric lighting of London-road and Lime-street.

Hove Electric Lighting Company, Limited.—The directors have declared an interim dividend for the half-year to June 30 last at the rate of 4 per cent. per annum.

Postal Telegraph Cable Company.—The directors of the Postal Telegraph Cable Company, 253, Broadway, New York, announce a quarterly dividend of 1 per cent. on the capital stock.

Coventry.—At the meeting of the City Council the corporate seal was affixed to a mortgage of the general district fund for raising £9,000 at 3 per cent. in respect of electric lighting.

Eastern Extension, Australasia, and China Telegraph Company, Limited.—The directors have declared an interim dividend for the quarter ended June 30 last of 2s. 6d. per share, free of income tax.

Windermere.—In respect to the agreement with Mr. Fowkes as to the lighting of the electric lamps, the Urban District Council have left it with the Highways Committee to complete the arrangements.

Removal.—Mr. Sidney à Court has removed from 19, Old Queen-street, S.W., to more commodious offices in Artillery-mansions, 75, Victoria street, S.W., to which building he is consulting engineer

Isle of Man Tramways and Electric Power Company, Limited.—The directors recommend an interim dividend for the past six months at the rate of 7½ per cent. per annum on the ordinary share capital.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending September 27 amounted to £1,168, as compared with £1,266 in the corresponding week of the previous year, being a decrease of £98.

West Ham.—The District Council have approved of the electric lighting scheme prepared by their electrical engineer, Mr. J. J. Steinitz, and it is proposed to borrow £50,000 for the purpose.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ending September 25 were £2 223. 19s., compared with £2 062 2s. 8d. for the corresponding period of last year, being an increase of £161. 16s. 4d.

Chiswick.—At a meeting of the District Council the Surveyor, in reply to a question with reference to the electric lighting station, said that as things stood at present the electric lighting system could be established in four or five months.

The Czar's New Yacht.—The new Russian imperial yacht, the "Standart," in which the Russian Emperor went to Scotland, is lighted throughout by electricity. The yacht is 425ft. in extreme length, and the engines have a total of 15,000 h.p.

Heathman's Ladders—We are informed that no less than 10 of Heathman's patent telescopic tower ladders are now employed by the arc lamp trimmers of Edinburgh City, and similar ladders have been recently supplied to Fort William, Ayr, Glasgow, and Dover.

New Mutual Telephone Syndicate, Limited.—This Company has been registered as a guaranteed company, with a membership of 20, each of whom is liable for the sum of £100 in the event of winding-up, to carry on the general business of a telephone company.

Automatic Time Switches.—The Keighley Electrical Engineering Company, Limited, of Alexandra Works, Keighley, Yorks, send us catalogues of automatic time switches, registers, and time-checking machines, and electrical apparatus, and machinery.

The Jandus Arc Lamp.—Messrs. Drake and Gorham send us a list of testimonials they have received from users of the Jandus arc lamp among which we notice one from Dr. J. T. Bottomley, of the University of Glasgow, and another from Mr. W. H. Preece, C B.

Personal.—The Huxley Scholarship of £60 for three years at the Central Institution, South Kensington, has been awarded to Mr. J. M. Donaldson, who was formerly under Mr. W. Perren Maycock, of Croydon, and subsequently proceeded to Finsbury Technical College.

Croydon—The electric lighting of the Town Hall having been so successful, the Thomson-Houston Company, who are the contractors for the installation, have received permission to begin the lighting of private houses. North End is shortly to be lighted with arc lamps.

Electric Lighting Extension Syndicate, Limited.—This Company has been registered, with a capital of £5,000 in £1 shares, to enter into an agreement with H. C. Hodges and C. O. Bastian, and to carry on in London and elsewhere the business of suppliers of electricity in all its branches.

City and South London Railway.—The returns for the week ended September 27 were £925, compared with £823 for the corresponding period of last year, being an increase of £102. The total receipts for the half-year 1896 were £11,813, compared with £10,971 last year, being an increase of £842.

Tunbridge Wells.—We are informed that the enlargement of the electric lighting station is now practically complete, and that additional machinery will be running shortly. So fast is the use of the electric light extending that a further extension of the works will soon have to be considered.

Bexhill—A letter from the parliamentary agents in reference to the steps to be taken with regard to the proposed insertion of a purchase clause in the Bill about to be promoted by the electric lighting company was read at the meeting of the Urban District Council, and referred to the Highways Committee.

Telegraphs in the States.—According to reports from the United States, the Postal Telegraph Company has taken over the telegraph lines of the Chesapeake, Ohio, and South-Western system heretofore operated by the Western Union. The system covers 400 miles of railway, 1,500 miles of wire, and 50 offices.

London.—The reopening of the Church of St. Mildred, Bread-street, which has been closed for cleaning and the installation of the electric light, will be delayed for probably six months. The concrete floor, which covers the old burial vaults, has cracked and sunk, owing, it is believed, to the weight of the scaffolding erected for the purpose of cleaning the church.

Dundee.—A Bill has been prepared by the Town Council to obtain additional borrowing powers for an extension of the electric lighting system. So far little has been done in lighting the streets by electricity, but it is now proposed to take a forward step in this direction. Various officials have been asked to report on the matter, which will be dealt with at an early meeting of the Board.

Paterson and Cooper.—The business of Messrs. Paterson and Cooper, of European Works, Pownall-road, Dalston, electric light and power and telephone engineers and contractors, is being carried on by the trustee, Mr. Edward C. Moore, pending a sale to, or amalgamation with, some business of a similar character. The showrooms are at Victoria-street, Westminster, and at Glasgow.

Forthcoming Exhibition.—We have received particulars of the Hardware, Machinery, Ironmongery, Inventions, Electrical, and Allied Trades' International Exhibition and Market, which will be held in the Royal Agricultural Hall from August 2 to 9, 1897. An exhibition on similar lines, but applying particularly to electricity, will be held at the same place from June 23 to 30, 1897.

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The Central London Railway.—Mr. A. Cates, the umpire, has now issued his award in reference to the claim for compensation brought by the Duke of Bedford against the Central London Railway Company. The property taken comprised 133, 134, 135, and 136, High Holborn, the site of which is to form the British Museum station of the Central London Railway. The award is for the sum of £9,279.

Hoylake and West Kirby.—At a meeting of the General Purposes Committee, which was held just before the District Council meeting, resolutions were passed that no action should be taken in promoting a Bill for purchasing the undertaking of the gas and water company, and that the Council should make application for electric lighting powers for the district. At the Council meeting these recommendations were confirmed.

Sheffield. After their return to England on Tuesday next, the motor deputation appointed by the Sheffield City Council will visit a number of towns, including, possibly, Bristol, Edinburgh, Glasgow, Blackpool, etc., and then they will present to the Corporation a full report of their doings. It is expected that the report will run much on the same lines as that of the Glasgow deputation, which, it will be remembered, strongly recommended the adoption of the overhead system.

New and Mayne, Limited.—This Company has been registered, with a capital of £150,000, to acquire the business carried on by A. G. New and A. J. Mayne, trading in co-partnership as New and Mayne, at Palace-chambers, 10, Bridge-street, Westminster, Woking, and elsewhere, and to carry on the businesses of electrical engineers and contractors, electricians, manufacturers and suppliers of electricity for heat, light, or motive power, and appliances of all kinds used in connection therewith, etc.

Horsfall Engineering Syndicate, Limited.—This Company has just been registered, with a capital of £50,000, to carry on at Leeds and elsewhere the business of makers or builders of furnaces for the destruction of town or other refuse, or for general purposes, to construct, maintain, and work any machinery or plant for the generation of electricity, to be used for lighting or other purposes, to undertake the supply of electricity to public bodies or private consumers, and to carry on the business of mechanical engineers.

Dewsbury.—In addition to the wiring of the technical school classrooms and corridors, etc., now being proceeded with by a large staff of men in the employ of Mr. A. Richmond Turner, the contractor, an installation is being put into the warehouses and offices of Messrs. F. W. Reuss and Co. There will be an addition to the number of shops using incandescent lamps, and probably orders for others to be supplied with the electric current will shortly be handed in to the Lighting Committee of the Corporation. The prospect for the coming season is regarded as good.

Portsmouth.—During the annual meetings of the Free Church Federation of Hampshire and Portsmouth and District Nonconformist Association in the town hall, and while an organ recital was proceeding, the building, which is illuminated with the electric light, was plunged into total darkness. It was afterwards announced that Alderman G. Ellis (chairman of the Electric Lighting Committee) had sent a message to say that one of the main cables had failed and could not be repaired that night. A supplementary cable was afterwards put in, and the light was switched on about nine o'clock.

Southwark.—The Works Committee recommended, at the meeting of the St. George's Vestry, that permission be given to the National Telephone Company to lay underground mains throughout the parish at a rental of £500 per annum to the Vestry for the privilege. Mr. Hilton opposed this extravagant charge. The Telephone Company had largely assisted the commercial community; the Vestry should review their proposal. He moved that the matter be referred to the committee in order that a deputation might wait upon the company to consider terms. Mr. Redman said that, as the Telephone Company was prosperous, they should pay a commensurate rent. The amendment was adopted.

Change of Address.—Messrs. H. M. Salmony and Co., electrical engineers, of London and Birmingham, have removed their offices from 61, Charing Cross-road, London, W.C., to 118-120, Charing Cross road. The removal is in every respect a desirable one. The new premises are very capacious and roomy, and when finally fitted up will look very imposing. There is a useful basement, a convenient saleroom, showrooms, offices, and storerooms, and Messrs. Salmony have the whole of the five floors at their disposal. All the latest designs and improvements in electric machinery and fittings and telephonic apparatus will be shown to the best advantage, and handsome arc light brackets have been fixed on the front of the building.

Motor Carriages.—What is claimed to be the first catalogue of motor carriages has just been issued by Messrs. Julius Harvey and Co, 11, Queen Victoria street, London, E.C. The little book, which is very well got up, contains illustrations and particulars of motor carriages at prices ranging from £130 for two-seated carriages to £300 for six-seated carriages. Their motor omnibus or commercial traveller's carriage can be obtained for £325, and details are also given of motor delivery vans and motor cycles. The vehicles all appear to be of light construction and elegant design, if the illustrations afford any criterion. At the end of the catalogue is published a reprint of the new Act of Parliament relating to the use of motor carriages.

Hanley.—At a recent Town Council meeting the Electric Lighting Sub-Committee reported that, owing to the increased demand for electricity, it was desirable that advantage be taken of the clause in the agreement with Messrs. Ferranti for the provision of a second engine, and that further application to the Local Government Board for borrowing powers be made. They recommended that the second engine for the electricity works contracted to be supplied by Messrs. Ferranti for the sum of £3,300 be ordered. In moving the adoption of the report, the Chairman said the electric installation was paying its way, and that with a reduced charge per unit it was calculated that the Council would not lose anything. The motion was agreed to.

Derry.—At the meeting of the Lighting Committee of the Corporation a report was read from the Lamp Committee embodying the recommendations and suggestions as to changes, etc., in position of electric light columns made by the members who drove round to inspect. The committee read a number of recommendations, including removals repairs, and relighting, and after a brief discussion the recommendations were ordered to be carried out. It was ordered to advertise for tenders for coal for the generating station. Mr. Christie, electrical engineer, read a report respecting the additional cost of keeping all the electric lamps lighted from dusk till daylight. The cost of running the light for 12 months was £2,026, and he estimated that to keep all the lamps alight from dusk till daylight would cost about £400 a year more.

Leicester.—At a quarterly meeting of the Town Council, Alderman Lennard submitted the financial statement of the Gas and Electric Lighting Committee for the past half-year, showing that the net profit, after paying interest on the capital of the undertaking, was £11,571. 0s. 10d., out of which £3 262 had been paid to sinking fund, leaving a balance of £8,309 to be applied at the end of the financial year as the Council might direct. The result of the working of the electric light department for the half year was a loss, after charging £584 on sinking fund account, of £723. 0s. 5d., after taking credit for £151, the profit from the electric lighting fitting business. The total loss in connection with this department now amounted to £2,060, but Alderman Lennard was very sanguine that the next half-year's working would wipe off the loss during the past six months, and that in 12 months' time the department would pay a profit that would recoup the loss on the first year's working. The report was approved.

Birmingham.—A proposal is on foot to connect Walsall and Birmingham by a tramway. Messrs. A. Dickenson and Co., electrical and civil engineers, Birmingham, acting on behalf of clients, recently made application to Walsall Town Council and to Staffordshire County Council asking permission for the line to be laid, and these bodies have asked for particulars, which are now in course of preparation. Walsall Town Council, who perhaps have the largest interest in the route, are generally favourable to the proposal, subject, of course, to an agreement being come to on points of detail. The idea of the promoters of the scheme for whom Messrs. Dickenson and Co. are acting is to take advantage of the powers conferred by the Light Railways Bill and construct an overhead electric traction along that part of the country road between Perry Barr and Walsall, though in the more thickly-populated district the line would be laid as an ordinary tramway. It will be a line somewhat similar to that between Kidderminster and Stourport.

Hawaii.—The report of the directors of the Hawaiian Tramways Company, Limited, for the year ending June 30 last, to be presented to the general meeting to be held at the Cannon-street Hotel on October 6, states that a change of the motive power to electricity has been under the serious consideration of the directors. A report has been furnished by an agent of the General Electric Company, of Boston, U.S.A., who visited Honolulu specially for that purpose, and estimates based on his report have been made. These estimates have been carefully gone into, and in view of the cost of a conversion the directors cannot feel justified in recommending the introduction of electricity under the existing concession held by this company. The authorities have, however, been approached, and it is hoped that certain facilities may be granted which will remove the present difficulties and enable the company to carry out an alteration which would undoubtedly be popular in Honolulu, and, under conditions, might be of advantage to the shareholders.

Non-Magnetisable Watches.—We have received from Messrs. Smith and Son, of 9, Strand, W.C., their catalogue of watches and clocks. With regard to the former you take your pick between gold, silver, steel, nickel, and aluminium. Messrs. Smith and Son, however, lay special stress upon the attention they pay to non-magnetisable watches. There is no particular reason—except old custom and the inherent conservatism of human nature—why all watches should not be made non-magnetisable now that a magnetic field is as much a thing to be reckoned with as a change of temperature. But some watches are not new and others are still made with a steel balance in the old way, consequently Messrs. Smith and Son announce that if they are lever watches they can be made practically non-magnetisable for from £2 to £3. If the customer wants such luxuries as palladium hair springs he must naturally pay more. With a Swiss watch it appears that the best thing to do is to change it for another, as the expense comes to much the same.

Brighton.—The application of the National Telephone Company for permission to lay wires underground in various streets has been again before the Works Committee of the Town Council. The borough surveyor furnished a report on the subject, in which he stated that the company had amended the route according to his suggestion; but he reminded the committee that several lines of wires would be laid, and that manholes would have to be constructed at intervals of 150 yards, and also at all points where a deviation in the line became necessary. As the streets are narrow

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and there is a probability that either they may frequently be broken up to obtain access to the wires, or the manholes will be frequently in use, the matter resolved itself into one of principle and expediency. The surveyor therefore urged upon the committee that they should consider whether the underground or the overhead system is best in the interests of the public. The committee decided to grant the permission asked for. Preparations are being made for extending the electric lighting of Brighton along the Lewes road, the work of excavating the road for the reception of the lofty lamp-pillars having been started.

Fulham. -The Vestry have received a letter from the County of London and Brush Provincial Company, Moorgate-street, stating that they should be glad before a final decision was arrived at by the Vestry with respect to applications for provisional orders to have the opportunity of attending and placing fully and fairly before them the advantages which they considered they should be able to offer them with respect either to taking over the order which they might obtain, or as to the terms which they would agree with them beforehand, as was done last year in the case of their application from Camberwell. They might mention that their station at Wandsworth was now approaching completion. The delivery of plant had been commenced, and they would be in a position to supply current from there and for the coming winter's lighting. Their mains were already laid to Putney Bridge, and in the event of the Vestry consenting to their proceeding with their application they could continue along across Putney Bridge, laying their mains throughout their district and giving a supply direct by the autumn of 1897. They would also propose to make it part of their agreement that the Vestry should have the option of purchase within a short term of years of the whole of the distributing mains. The letter has been referred to the Electric Lighting Committee.

Maidstone.—At the meeting of the Urban District Council the Electric Lighting Committee reported that they had received formal notice that the Municipal Electric Light and Power Corporation, Limited, intend to make application to the Board of Trade for a provisional order under the Electric Lighting Acts; that they had received from Mr. W. C. C. Hawtayne a new proposal for carrying out the Council's provisional order, and the committee were making full enquiries in reference to the same; that they had received a letter from Mr. Thomas King to the effect that he proposed to place electric lighting cables across certain streets in the borough unless the Council intended to proceed at once with the powers under their provisional order. The committee had replied that they were fully considering the whole question, and could not recommend the Council to grant him permission to place any wires across the street. Alderman Ellis, in moving the adoption of the report, said he thought the subject of electric lighting was dead for 12 months, according to the decision of the Council; but the town clerk had received the communications mentioned in the report, which of course reopened the matter again to a certain extent. The report was adopted. The apparatus for making use of the Röntgen rays in connection with surgery is about to be introduced to the West Kent General Hospital.

Middlesbrough.—At a meeting of the Middlesbrough Streets Committee, the deputy town clerk read a letter from the Imperial Tramway Company stating that the directors purposed submitting an application to the Corporation for certain alterations and extensions of the tramway system, together with the reconstruction of the present lines in order to admit of the whole being worked by electricity. Inasmuch as the application would have to be dealt with in due course by the Streets Committee, the directors invited the whole of the members of the committee, together with the town clerk and the borough engineer, to visit Bristol for the purpose of inspecting some of the most recent installations of electric traction which had been in successful operation for close on 12 months under the administration of the directors and officials of the Imperial Tramway Company. Councillor Redmond did not think they ought to take advantage of the courteous and generous offer of the tramway company. Any of them could see what was being done in the direction of tramway traction by electricity without going to Bristol. They could see what was being done at Hartlepool. He proposed that they adopt the system of electric traction. The Chairman said he thought it was rather premature to take any definite action. They should first have the scheme before them. After some discussion it was ultimately resolved to ask the tramway company to submit plans of the scheme they proposed to adopt.

Edinburgh.—The electric light extension is to cost between £60,000 and £70,000. Treasurer M'Crae, in moving the adoption of the Assessment Committee's report at the meeting of the Town Council, said that as the Council had as yet given no decision as to the electric light account surplus, the City Chamberlain, for the purpose of estimating, had to take that surplus into consideration according to the Act of 1879. That surplus and the surplus estimated for the current year gave a seeming advantage of £7,000 odd. He wished to make it clear that the surplus last year on the electric lighting account had been carried forward to the electric lighting of this year, and the Council would be called upon to say what was to be done with that surplus. Although this £7,000 was seemingly a credit they were taking advantage of, he had to state that on the other side they were to receive a sum from the Electric Lighting Committee of £5,900, which was the amount of the several sums paid from the rates on account of the electric light before it was a revenue-producing subject. So that if they took £5,900 and the surplus of £1,596, they were able to pay their way, although the Council should not vote any further sum from the electric lighting to the rates. It might be said that that was cutting it rather fine. He did not think so. Hitherto their estimates had not been exceeded. In fact, they had always had a margin to go upon, and for the last five years at least they had always had a surplus, and he had not the slightest doubt that this year they would also be able to pay their way. The report was adopted.

Wimbledon.—The annual report of the Urban District Council for the year ending March 31 last contains a history of the electric lighting movement from the time when a report on the best means of lighting the district with electricity was obtained from Mr. A. H. Preece, and application was made to the Local Government Board for sanction to a loan of £32,000 for carrying out the work. An enquiry was held by an inspector of the Local Government Board on November 1, 1895, at which the Wimbledon Ratepayers' Association opposed the scheme. After a long delay the Local Government Board, without expressing any opinion on the merits of the scheme, refused to give the sanction until the Council had obtained a renewal of their license from the Board of Trade, or a provisional order, the existing license expiring on October 2, 1896. It was then too late to apply for a provisional order in 1896, and the Board of Trade had decided not to grant any more licenses except under very special conditions. The Board of Trade were therefore asked if they would grant a renewal of the existing license for such a period as would be necessary to enable the Council to obtain a provisional order. They replied that they would grant a renewal of the license for a period not exceeding two years at the expiration of the existing license. The Local Government Board, however, intimated that they would only grant their sanction for the period of the license. This would have been useless under the circumstances, and the matter remained in abeyance pending the decision of the Council as to whether they will apply for a provisional order in 1897. The Council have since decided to apply for the order.

Dover.—At the meeting of the Town Council the Lighting Committee of the Town Ward reported that estimates for the lighting of Biggin-street had been obtained from the electric light company and the gas company, and they asked the Council to decide which system should be adopted, and then to refer the matter back to them to decide the positions, etc., of the lamps. The electric light company tendered to light Biggin-street with nine arc lamps in accordance with the existing agreement at £30 per annum. The gas company tendered to light Biggin-street with 33 incandescent lamps, 30 yards apart, twice the number now existing, at a total cost of £123. 15s. per annum. A memorial was received from all the inhabitants of Cannon-street and Biggin-street, with two or three exceptions, requesting the Council to light the street with electric light. Councillor Mackenzie moved that the memorial should be acceded to and the electric light company's offer be accepted. He believed electricity to be the light of the future for public lighting. Dover was going ahead, and if they were to keep ahead Dover must take the new light for the better illumination of the town. As regards the cost, the difference in such a street between gas and electricity was small. After considerable discussion the motion was put, and carried by six votes to two. It was decided to postpone the alteration of the lamps in Worthington-street until the new lamps of the electric light were seen. The Town Ward Lighting Committee were given the direction of placing of the lamps in Biggin-street.

Unfenced Machinery.—At the North London Police Court on Tuesday the London and Lancashire Electric and General Engineering Company, of Kingsland Green, was summoned before Mr. Paul Taylor for non-compliance with the Factory and Workshops Acts of 1878 and 1895 in not having machinery and gearing on their premises properly fenced. Mr. G. J. L. Blenkinsopp, one of her Majesty's inspectors of factories, prosecuted; and the company made no legal appearance. A clerk was, however, allowed to watch the case on their behalf. Mr. K. H. Garvie, another inspector attached to the Home Office, said that he visited the premises on July 31 and found a gas-engine at work, unfenced, in the workshop. Witness had visited the premises three times within 12 months, and each time he had found engines and gearing unfenced. On the occasion of the last visit witness asked how long the gas-engine had been at work in its present position, and he was told three months. The secretary and the manager of the company had been repeatedly warned of the requirements of the Act, an abstract of which was posted in the factory. Mr. Blenkinsopp said he regarded this as a case of great neglect. The clerk who attended for the company said that the company were waiting to hear what they were required to do. Mr. Paul Taylor said it appeared to be a gross attempt to evade the Act. The company must be taught that they could not set the law at defiance. The full penalty of £10 and costs was imposed. On the application of Mr. Blenkinsopp, the magistrates further made an order for the fencing of the machinery within 14 days.

Electric Transmission of Power Machinery.—The Arniston Coal Company, of Gorebridge, N.B., have contracted with Ernest Scott and Mountain, Limited, electrical and general engineers, Close Works Newcastle, for the supply of an electric pumping plant, for their colliery, of considerable size. The generating machinery consists of: Two horizontal engines with Corliss trip expansion gear, each engine being capable of giving 300 b.h p., with a steam pressure of 120lb. per square inch when running at a speed of 84 revolutions per minute, the steam being supplied by two Lancashire boilers, each 30ft. long by 8ft. diameter, for a working pressure of 140lb. per square inch. The engines drive by rope on to two continuous-current dynamos, each machine giving an output of 200,000 watts at an E.M.F. of 525 volts. These dynamos are placed on sliding bedplates, so that the slack of the belt can be taken up whilst they are running. The current from the dynamo is taken to a dis-

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tributing switchboard in the engine-room, the switchboard connecting with two pairs of main cables, which run down the shaft to the terminal-box at the pit bottom, in which switches are placed, so that either or both dynamos can feed either circuit, the underground pumping being divided into two separate circuits. The object of placing four cables in the shaft is to prevent any possibility of breakdown through the cables being accidentally damaged, as any pair of cables can, in case of emergency, carry sufficient current to enable the plant to run without stoppage. Underground there are four sets of three throw pumps of Messrs. Scott and Mountain's improved type, with independent interchangeable pump bodies, valve-boxes, suction and delivery branches, and air-vessel, one pump delivering 500 gallons of water per minute against a head of 270ft., along a road to a sump at the bottom of the shaft about 1,200 yards away. At this point a second pump of the same size—viz., to deliver 500 gallons—is placed, and forces to bank against a head of 690ft. Two dip pumps are being provided at present, each delivering 100 gallons per minute against a head of 450ft., but at a future date two additional sets of pumps will be provided. Sufficient capacity in the dynamos and generators has been allowed for the working of the additional pumps, and also for the electric haulage gears and other transmission of power machinery which may be required for the working of the colliery at a later date. The cables down the shaft are heavily armoured, as a protection against mechanical injury, the underground cables being highly insulated.

Southampton.—At the meeting of the Corporation the Electric Lighting Committee reported the receipt of the following sanctions to loans: for the purchase of the undertaking, £21,100 for a period of 15 years; for new buildings, and extension works and mains, £28,900 for 25 years, and for the purchase of additional land, £5,300 for 50 years. The town clerk was instructed to apply to the Local Government Board for an extension from 25 to 30 years for the repayment of the loan of £28,900, and the Finance Committee requested to provide a cheque for £21.100 for the purchase of the undertaking. The committee considered the subject of making arrangements for the taking over of the undertaking and the staff, and resolved that the staff of the electric lighting company be engaged at the same salaries and wages as they were receiving, and subject to the terms of their present engagements; and that Mr. Miles (Mr. Hamilton's clerk) be appointed accountant and collector at a salary of £120 per annum. Alderman Bone proposed the adoption of the report, stating that after waiting a long time they had obtained sanction for the borrowing of the money for the electric light works, and since the receipt of the sanction the sum of £21,100 had been paid over to the electric lighting company, and the works were now in the possession of the Corporation. The committee had no other alternative but to take over the staff, and in time they would be able to see if the officials were such as should be retained. Mr. Miles was acquainted with the work, but he would be subject to Mr. Ramshaw, chief accountant to the Corporation, though he would carry out the calculations and collection for the electric light. The engineer was away, but on his return the committee would take into consideration what extension the present plant was capable of, and also whether they could reduce the price of the current, so that they might induce, if possible, various inhabitants in East-street and other parts, where they hoped to extend it, to take the light. Mr. Batchelor seconded the proposition. Mr. McDonnell complained that they were taking over a large staff without knowing anything of their number, salaries, and the terms of their engagement, and elevating them to the position of Corporation officials. He proposed as an amendment that the matter be referred back to the committee for these particulars to be supplied. Alderman Bone gave particulars as to the wages, the whole of which would be not quite £10 a week. Mr. McDonnell still pressed his amendment, and Mr. Dunsford seconded, as the appointments should not be made without being advertised. After some discussion the amendment was withdrawn, and on a show of hands 28 were for the proposition and 5 against. Mr. Alderman Bone moved, "That as the electric lighting is now in the hands of the Corporation, it be referred to the Estates Committee to take the necessary steps to have the Council-chamber and municipal offices lighted by electricity forthwith." He thought it would be much more comfortable in the Council-chamber and indeed throughout the audit house if gas was superseded by electric light. Alderman Gilbert seconded, and the motion was carried.

Minster.—At the meeting of the Isle of Thanet Board of Guardians the following important report was received from the Lighting Committee: "The committee appointed to enquire into the question of lighting beg to report as follows: The amount paid last year for gas was £421, to which must be added for new burners, etc., about £20, and deducted for gas used in cooking nearly £23, leaving for lighting £419. But as the first quarter of 1895 was, owing to bad weather, an exceptionally heavy one, the committee consider £400 per annum a fair estimate to make for lighting the union under present conditions. This undoubtedly is too heavy an expenditure for the light obtained. A certain waste appears to the committee to have arisen from want of care in leaving lights on unnecessarily, and they recommend a stricter supervision in this respect. They also think a further check might be obtained by a daily record being kept of the reading of each meter. This waste, however, goes a very little way in explaining the heavy expenditure. The chief cause is to be found in the high price charged for the gas and its inferior quality. The illuminating power is low, and the fumes thrown off are offensive and insanitary. To a limited extent incandescent burners have been fitted in the house, and the committee had under consideration the general adoption of this system, but the reports from your officers do not encourage this. The impure condition of the gas tends to clog the incandescent burners, and although, with care, where the lights are under the direct control of your officers, this difficulty may be overcome, in other parts of the union where they have been tried the life of the mantles has been so short that their general adoption would entail considerable addition to the annual cost of lighting. Acting under the authority of the Board, the committee have obtained reports from three separate firms of electrical engineers and contractors on electric lighting. These reports are submitted herewith. Summarised they are as follows: Harraps'—installation £1,550, annual cost £270, lights 410; Glover's—installation £1,484, annual cost £200, lights 383; Mackie—installation £1,130, annual cost £287, lights 368. Messrs. Glover make no allowance for depreciation. The existing number of gas-burners is 310, and the annual cost of gas £400. It is therefore clear, assuming the above figures to be correct, that on either estimate a large saving would be effected by the adoption of the electric light. The committee do not hide from themselves that all such estimates—especially in regard to the annual cost—must be accepted with reserve, but they have assured themselves that the gentlemen consulted are practical and competent men, and that their estimates have been drawn with care, and guided by their reports the committee have arrived at the conclusion that under the present conditions of the supply of gas, the electric light, both from an economical and sanitary point of view, is preferable." After a long discussion it was decided, on the motion of Mr. Matthews, seconded by Mr. Hermitage, that the consideration of the subject stand over until the clerk has endeavoured to obtain some information on the question from other institutions.

Torquay.—The Town Council intend to proceed with their electric lighting works as speedily as possible. It is only the other day that the Local Government Board signified their sanction of the scheme and the proposal to borrow £23,000, but the general conditions and specifications for tendering have already been agreed upon, and will receive the approval of the Council next week. In the general conditions it is laid down that the work must be completed within six months of the date of the contract. Following is a general outline of the works: There are to be three boilers of the water-tube or modified marine type, capable of working at a pressure of 150lb. per square inch; two Worthington duplex feed pumps, and one of Druitt Halpin's feed storage cylinders, 6ft. in diameter and 20ft. in length. The engine-house plant is to include three high-speed compound engines, preferably of the three-crank single-acting type, each capable of driving a 125-kilowatt alternator as a maximum at a pressure of 130lb. in steam-chest. The engines are to have all the working parts closed in, and are to be arranged for driving alternators direct. The speed shall not exceed 450 revolutions per minute. One engine of the same type, capable of driving a 25-kilowatt alternator at about 500 revolutions per minute, is to be provided for day load. "The engines must run at all loads without perceptible noise or vibration." There are to be three alternators, one to be coupled direct to each of the larger engines, and each to be capable of delivering to the external circuit 125 kilowatts at an E.M.F. of 2,000 volts, and of maintaining this load without strain for an indefinite period at a speed not exceeding 450 revolutions per minute. The main foundations for engines and alternators are to consist of a block of cement concrete solid, with the exception of any necessary trenches for pipes, etc., and to be at least 8ft. thick. Upon the concrete bottom the contractor is to place a layer of hairfelt, of such a depth that the weight of foundation shall not compress it to less than 2in. in thickness. Above this, and under concrete, must be placed two layers of good roofing felt, so arranged as to break joint. There will be five feeder circuits and one street-lighting incandescent circuit, all of the concentric type. Feeders and street lighting mains are to be laid in the following thoroughfares: Beacon-terrace and Victoria-parade, Strand, Fleet-street to town hall, Lower Union-street and part of Higher Union-street to Torbay Hospital, Higher Union-street from hospital to Torre Station, Torbay-road to Belgrave-road, Torwood-street. Feeders only are to be provided in the following: Torwood-street, Babbacombe and Stitchill roads, part of Lower Warberry-road, Higher Warberry-road, Meadfoot-lane, Parkhill-road and part of Middle Woodfield-road, Ridgway-road, Higher Erith-road, Meadfoot-road, Upper Lincombe road, and Belgrave-road. Arc lamp circuits are to be laid in Beacon-terrace, Victoria-parade, part of Torwood-street, Strand and Fleet and Union streets to Tor Station, Market-street to Ellacombe-green, Torbay-road to borough boundary, the Pier. Low-tensions mains are to be laid in Beacon-terrace and Victoria-parade, Strand, Fleet-street to Pavilion Hotel, and on to Tor Station, Torwood-street, Torbay-road to Cumper's Hotel, part of Park-road and Belgrave-road. Three extra ways are to be laid in stoneware casing in Beacon-terrace, Victoria-parade, and Strand; and two extra ways in Fleet-street to town hall, and Union-street to Torbay Hospital. The conductor is to be composed of copper having a conductivity of not less than 100 per cent. of Matthiessen's standard. All the cables are to be stranded, and each strand to be coated with pure tin. The conductor must be covered with fibrous or other approved material capable of absorbing an insulating oil or compound, and the insulation must be protected with a covering of lead, upon which will be two layers of strong tape or braid, so as to withstand moisture. The cables will all be laid 2½ft. deep in Doulton or other stoneware conduits, or, where several are in the same trench, in wooden troughing filled with bitumen. There are to be 70 arc lamps for street-lighting, upon ornamental lamp-posts of such a height that the globe of lamp shall be about 20ft. from the ground Thirty-kilowatt transformers are to be placed in pits at the junction of Fleet-street with the Strand; and 20-kilowatt transformers are to be

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placed outside the Queen's Hotel, near the Town Hall, and 70 yards above Market-street; while 10 kilowatt will be in generating station, opposite Upton Church, end of Vansittart-road, near Clarence Hotel, top of Market street, and two in Belgrave-road. Mr. Garrett, the borough surveyor, will erect the chimney shaft at the central station, and the coal-stores near the Bath Saloons.

PROVISIONAL PATENTS, 1896.

SEPTEMBER 21.

64a. **Improvements in and relating to electric or other tramways** Francis Krizik, 433, Strand, London (Date claimed under Patents Rule 19, January 1, 1896.) (Complete specification.)

64b. **Improvements in or relating to electric tramways or railways.** Francis Krizik, 433, Strand, London (Date claimed under Patents Rule 19, January 1, 1896.) (Complete specification.)

20864. **Improvements in and connected with automatic and other electric meters.** Francis Malger Staunton, 77, Chancery-lane, London.

20881. **Improved means for jointing and protecting electric conductors specially applicable for use in the wiring of buildings** Victor George Middleton, 46, Lincoln's-inn fields, London.

20902. **Improved mechanism for electric arc lamps** P. R Jackson and Co, Limited, and Louis Carl Henry Mensing, 166, Fleet-street, London. (Complete specification.)

SEPTEMBER 22.

20961 **Improvements in incandescent electric lamps.** John Thomas Lister and William Selah Chamberlain, 75, Chancery-lane, London. (Complete specification.)

20962. **Improvements in or connected with electric railways.** James Thomas Rossiter and the British Electric Traction (Pioneer) Company, Limited, Norfolk House, Norfolk street Strand, London.

20963. **Improvements in switches for use in connection with electric railways** James Thomas Rossiter and the British Electric Traction (Pioneer) Company, Limited, Norfolk House, Norfolk-street. Strand London.

20964. **Improvements in current collectors for electric railways** James Thomas Rossiter and the British Electric Traction (Pioneer) Company, Limited, Norfolk House, Norfolk-street, Strand, London.

20966. **An attachment for electric incandescence lamps** Forest William Dunlap and John Robert Quain, 60, Queen Victoria-street, London.

20969. **Improvements in the armourings or coverings of electric cables** Henry Edmunds, 47, Lincoln's-inn-fields London.

20981. **Improvements relating to the production, regulation, and utilisation of electric currents of high frequency, and to apparatus therefor.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Nikola Tesla, United States.) (Complete specification.)

20984. **Improvements in electric brakes.** The British Thomson-Houston Company, Limited, 70, Chancery lane, London. (Alexander F. Macdonald, United States.) (Complete specification.)

21003. **Improvements in speed-retarding appliances for electricity meters.** Reginald Page Wilson, 191, Fleet-street, London.

21009. **Improvements in construction of low-tension dynamo-electric machinery.** Francis Edward Elmore, 28, Southampton buildings, Chancery-lane, London.

21027. **Improvements in electrolytic apparatus.** William Lloyd Wise, 46, Lincoln's-inn-fields, London. (The Aluminium Industrie Aktien Gesellschaft, Switzerland)

SEPTEMBER 23.

21055. **Improvements in electric fittings.** Edward Jesse Piper, 34, Victoria-street, Westminster, London.

21116. **Improvements in ticket-issuing apparatus for the electrical staff instruments on single lines of railways** John Patrick O'Donnell, 70, Palace-chambers, Westminster, London. (John William Wainwright Hopkins, Argentine Republic.)

SEPTEMBER 24.

21128. **Improvements in metallic posts for fencing telegraph and similar purposes.** William Tozer, 95, Finsbury-pavement, London.

21147. **Improvements in or connected with coin-freed or actuated electricity meters.** George Ellis and George Hinde Nisbett, 15, Water-street, Liverpool.

SEPTEMBER 25.

21236. **An electric regulator.** Walter Emmott, 1, South-parade, Halifax.

21273. **Improvements in or relating to electric storage batteries.** John Evelyn Liardet, 9, Warwick-court, Gray's-inn, London.

21293. **Improvements in electrical doorbolts.** Samuel Flood Page, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

SEPTEMBER 26.

21340 **Insulated conductors and improved collectors for electric tramways** Robert Henry Smith, 124, Hagley-road, Birmingham.

21365 **Improvements in electric meters.** Emanuel Bergmann, 18, Buckingham-street, Strand, London.

21380. **Improvements in apparatus for supplying electricity to electrically-propelled railway and tramway vehicles.** William Lloyd Wise. 46, Lincoln's-inn-fields, London. (Alfredo Diatto, Italy)

SPECIFICATIONS PUBLISHED.

1895.

16557 **Electro-deposition of gold and silver.** Andreoli.

18487 **Electrolytic manufacture of ferro-manganese, ferro-chrome, ferro-aluminium, ferro-nickel, and other "alloys" having an iron base** Heibling.

18583. **Means for making electric connection between lengths of rail and the like.** Edmunds.

19272 **Steering of electric or steam carriages, cycles, bath chairs, or other like vehicles** Kesterton.

20335. **Electric arc lamps.** Collinson.

20636. **Telephone instruments.** Truss.

20681. **Ventilation of transformer-boxes, road and junction boxes, conduits, and the like, used in the distribution of electrical energy.** Penson.

20696. **Electric switches.** Nalder and Soames.

20821 **Reflector for electric arc lamps** Fabris.

21433. **Holders or carriers of electrical incandescent or glow lamps** Evered.

1896.

11429. **Electric brakes for electrically-propelled vehicles.** The British Thomson-Houston Company, Limited (Potter)

13729 **Process for multiple telegraphing with Morse apparatus.** Cerebotani and Bernstein.

14846. **Conducting contacts with carbon or other non-metallic electrodes** Siemens Bros. and Co., Limited, and Obach.

16790 **Telegraph-wire reel** Ehricht.

17125 **Conduit-tubes, more especially suitable for electrical conductors.** Lake. (Greenfield.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5½-5¾
Brush Company, Ordinary	3	¾ 1
—— Non. Cum., 6 per cent. Pref.	2	1⅛-1⅜
—— 4½ per cent. Debenture Stock	100	110-113
Central London Railway, Ordinary	10	10¼-10¾
——	2	4⅛-4⅝
Charing Cross and Strand	5	9½-10
Chelsea Electricity Company	5	7½-8
—— 4½ per cent. Debentures	100	114-117
City of London, Ordinary	10	16-17
—— 6 per cent. Cumulative Pref.	10	17½-18½
—— 5 per cent. Debenture Stock	100	131-135
City and South London Railway, Consolidated Ordinary	100	48 50
—— 4 per cent. Debenture Stock	100	136-128
—— 5 per cent. Pref. Shares	10	14¾ 15¼
County of London and Brush Provincial Co., Ordinary	10	8-9
—— 6 per cent. Cum. Pref.	10	13¾ 14¼
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
Edison and Swan United Ordinary	3	1¾-2¼
—— 4½ per cent. Debentures	100	103-106
Electric Construction, Limited	2	1½-1¾
—— 7 per cent. Cumulative Pref.	2	2½-3
Elmore's Copper Depositing	2	⅝ ⅞
Elmore's Wire Company	2	⅜ ⅝
W. T. Henley's Telegraph Works, Ordinary	10	18-19
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	3¾ 4¼
—— 7 per cent. Preference	5	8¾ 9¼
India Rubber and Gutta Percha Works	10	22-23
—— 4½ per cent. Debentures	100	105-108 xd
Kensington and Knightsbridge Ordinary	5	9½-10
—— 6 per cent. Pref.	5	8¼ 8¾
Liverpool Electric Supply, Ordinary	5	8-8½
Liverpool Overhead Railway	10	13⅜-13⅞
—— 5 per cent. Pref.	10	17⅛-17⅝
—— 4 per cent. Mortgage Debentures of £100	100	112½-114½
London Electric Supply	5	⅞-1⅛
Metropolitan Electric Supply	10	12½-13½
—— 4½ per cent. First Mortgage Debenture Stock	100	120-123
National Telephone, Ordinary	5	7⅜ 7⅝
—— 6 per cent. Cum. First Pref.	10	17-19
—— 6 per cent. Cum. Second Pref.	10	17-19
—— 5 per cent. Non. Cum. Third Pref.	5	6⅞-7⅛
—— 3½ per cent. Deb. Stock	100	107-110
Notting Hill Company	10	11½-12½
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8¼-8¾
—— £4½ shares	4½	7¼-7¾
Oriental Telephone and Electric Company	1	¾-⅞
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	105-107
Southampton Electric Company	5	4¾-5¼
St. James's and Pall Mall, Ordinary	5	11½-12½
—— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	40-43
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	—	8-8½
Westminster Electric Supply, Ordinary	5	10-11
Yorkshire House-to-House		7½-8

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NOTES.

The Junior Engineers.—The annual general meeting of the Institution of Junior Engineers will take place at the Westminster Palace Hotel on Friday, October 16, at 8 p.m.

Publication Received.—We have to acknowledge the receipt from Messrs. Witherby and Co., 326, High Holborn, W., of "Lean's Royal Navy List." This is published quarterly, and the present number is the seventy-sixth.

Self-Propelled Traffic Association.—A branch of the Self-Propelled Traffic Association has been formed at Liverpool with Lord Derby as president. Sir David Salomons is to deliver the inaugural address of the branch some time during the month.

Telegrams to Ecuador.—Communication over the Ecuadorian land lines appears to have been in a bad way for a long time. It is now announced that telegraphic communication with Guayaquil is interrupted, owing to a great fire which has occurred there.

The Value of v.—Mr. D. Hurmuzescu has been making a new determination of the ratio v connecting the electrostatic and electromagnetic units. According to a communication to the French Société de Physique, his result is a value between 30002×10^6 and 30005×10^6 cm/sec.

The Midland Engineers.—The general meeting of the Chesterfield and Midland Counties Institution of Engineers will be held at University College, Nottingham, on October 17, at 3 p.m. Members likely to attend the proposed meeting in Canada next autumn are asked to send in their names to the secretary.

Guttapercha.—According to the *Revue Industrielle*, Mr. Sarrazin has found a new source of guttapercha in the French Soudan. It is a creeping plant, the botanical name of which is given as *lythophilum album*, and is found growing in the Baleya and Sankaran districts. The possible supply from this source is put at about 100 tons per annum, if it could all be utilised.

Changing the Frequency.—A device for changing the frequency of an alternating current at the place of consumption (Gutmann's method) has been described in the New York *Electrical Engineer*. An armature wound like a Gramme ring has connections at symmetrical points and revolves in a field produced by the alternating current. The current generated in any one of the sections of the armature will then have a frequency bearing a definite ratio to that of the current exciting the field.

Accident.—Last Friday evening Mr. John H. Whittaker, electrical engineer, of Dudley, was admitted into the Guest Hospital suffering from a severe dislocation to the forearm and injuries to the face. Mr. Whittaker, it is stated, while superintending some operations in connection with the completion of the laying down of an electric lighting plant, got the sleeve of his coat caught between the driving-belt and the dynamo pulley, and appears to have had a narrow escape of receiving more serious injury.

The Cost of Calcium Carbide.—The sanguine estimates as to the selling price of calcum carbide that have at various times been put forward by the advocates of acetylene as an illuminant do not appear to be altogether pleasing to some of the companies that make it. The Neuhausen Company, for instance, has written to the *Zeitschrift für Beleuchtungswesen* protesting against estimates to the effect that its present price of about £20 per ton for the carbide may be reduced to nearly £9. Some reduction, it is said, may possibly be effected shortly, but nothing of this wholesale character.

Lighthouse Communication.—The "Smalls" lighthouse, situated 20 miles from the mainland at the entrance of St. George's Channel, and within signal distance of the Bristol Channel, was last week connected by cable with the mainland. The present intention is to enable the lightkeepers, in case of shipwreck, casualties, or distress, to give information for the use of the lifeboat and to the coastguard, but it is hoped that the postal authorities may be induced to also allow a mercantile signal station to be ultimately included.

Warning.—The Commissioner of Police has warned London householders against a thief who gains access to houses on the pretence of inspecting telegraph or electric light wires. This man is wanted by the police for numerous offences. He is usually dressed like a workman, and carries a coil of wire. As, however, he most probably looks at a daily paper, it is quite possible that he may discard the coil of wire for something else after this. The make-up and accessory wire was not very well chosen, but it would appear to have been good enough.

Electrical Exhibition.—It is stated in the *Newcastle Daily Chronicle* that there is to be an electrical exhibition next February at Newcastle-on-Tyne. "There being no permanent building adapted for showing heavy machinery and machinery in motion, a site on Pandon Dene has been secured, on which special temporary buildings will be erected, and these will be so arranged as to meet the requirements of the exhibits referred to. It is intended to be strictly an exhibition, and in no way an organisation for the sale of goods." The exhibition is a private speculation.

The Perils of Cable-Laying.—The Strand has been in a considerable mess lately, the responsibility for which must be apportioned between the road authorities, the electric lighting companies, and the clerk of the weather. One gentleman in Norfolk-street, by way of enforcing his views that even in the Strand quiet should be found at three o'clock in the morning, took a shot in the direction of the electric light workmen with a revolver. Subsequently, in an interview with Mr. Vaughan at Bow-street, he admitted that the protest was unjustifiably forcible. Mr. Vaughan thought 40s. would meet the case.

Obituary.—The death has been announced, at the age of 88, of the widow of the late Mr. Charles Darwin, the illustrious naturalist. Mrs. Darwin was the daughter of Darwin's uncle, Josiah Wedgwood, and the granddaughter of the founder of the Etruria works. The heredity of intellect is illustrated by the fact that the surviving children of the marriage include Mr. George Howard Darwin, F.R.S., Plumian professor of astronomy at Cambridge; Mr. Francis Darwin, F.R S., university reader in botany at Cambridge; and Leonard Darwin, late member for the Lichfield division of Staffordshire.

Submarine Telegraph Memorial.—The committee which is promoting a memorial of the foundation of submarine telegraphy held a meeting on Tuesday. The Earl of Selborne presided. Lord Kelvin was not present, but it was stated that his views as to the form that the memorial should take was that the bulk of the fund should be applied to the foundation of scholarships in connection with electrical science in London and Glasgow. A letter was read from Prof. Silvanus Thompson suggesting the application of a portion of the memorial fund to the erection of a permanent home for the Institution of Electrical Engineers.

Conductivity of Iron.—The result of some researches of Dr. Ebeling made at the Berlin Reichsanstalt were given some time ago in the *Zeitschrift für Instrumentenkunde*. He endeavoured to find whether magnetic heterogeneity could be determined by the electric conductivity. A constant

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current was sent through sample bars and the loss in voltage measured at fixed intervals along the bar. Those bars which had small differences in their magnetic qualities also had small differences in their electric conductivity, but the converse that homogeneous magnetic materials have an even conductivity had exceptions. This, however, might be due to mechanical faults in the material.

The First Under-Sea Telegraph.—The proposal for a memorial of the establishment of submarine telegraphy has naturally brought about some discussion as to who was the first to do it. Mr. F. E. Baines, formerly Surveyor-General of Telegraphs, has written to the *Times* claiming that the absolute first, "if not the true originator of, submarine telegraphs was the late Mr. C. V. Walker, F.R.A.S., telegraph engineer of the South-Eastern Railway. Mr. Walker, on January 10, 1849, carried out to sea from Folkestone two miles of covered wire, and through the insulated conducter thus submerged held telegraphic conversation with his chairman in London from the deck of a vessel afloat."

Motorcarts.—Of the 32 motorcarts and motor cycles that started in the race to Marseilles, 11 got back to Paris last Saturday. Three of these were tricycles. Until the time allowances have been reckoned up no one quite knows which is the winner, and just at present no one particularly cares. Fireworks, illuminations, pine trees without roots, other trees provided with satinette flowers and artificial fruit to remedy the obstinacy of Nature, that will not change her laws even in honour of the visit of a Czar to a Republic, occupy all that is left of Parisian attention. Here in England the Motorcar Club has changed the date of its procession of cars to Brighton from November 14 to October 24. As the new Act will not then be in force, it is to be assumed that the police have been—arranged with.

Scientific Education.—The controversy—if it can be called a controversy where one side only has spoken—in the *Times* on scientific education appears to have drawn to a close. There has, indeed, been one more letter from Sir Philip Magnus, but it contained little new. Sir Matthew White Ridley spoke upon the subject at the opening of the session of the Durham College of Science at Newcastle. One need not reproduce his speech, for unfortunately a Home Secretary need not be a person of any authority in scientific matters. He, however, threw out hopes of more grants to the university colleges of science. The subject has in general proved a mine of wealth to the unfortunate individuals that have to make speeches at the opening of schools and institutes, but the practical result seems to be that matters will be much as before.

Electric Work at Johannesburg.—A description originally appearing in the *Zeitschrift des Vereins Deutscher Ingenieure* supplies some further particulars as to the power transmission line erected by Messrs. Siemens and Halske for the Rand Central Electric Company. The buildings are chiefly in corrugated iron. Four triple-expansion engines of 1,200 h.p. each, of the Sächsische Maschinenfabrik, Chemnitz, will be coupled with Siemens's polyphase generators. The boilers are of the water-tube type. The generators are to run at 100 revolutions. The voltage will be transformed up to 10,000 volts, and transmitted by overhead lines for a total distance of 28 miles; the power station, which is at Brakpan being some distance from the nearest end of the field to be exploited for the present. A start is expected to be made very shortly.

Trade Exhibitions at Islington.—The opening of a series of trade exhibitions to be held at the Agricultural Hall, Islington, was the occasion of a luncheon on Friday last. Mr. Stanley Machin presided, and a remarkable feature of the toast list was that most of the speaking was done by the Press. However, they redressed the balance, which does not usually swing in that direction, by having afterwards quite a quantity of speeches which were not in the programme. The present exhibition relates to grocery; the turn of electricity and electrical fittings will not come till next August. But even in a grocery exhibition it is not safe to be certain that something electrical will not be found. In this case it was a dodge in the connecting up of electric bells, which has been brought out by Messrs. Jones and Collier, of Dartmouth, in view of the exigencies of shop doors, but which might easily have a much wider application. The principle is that instead of the bell-push completing the circuit directly, it sets a chain pendulum swinging, which makes a contact at every vibration. One push, therefore, gives a succession of "strokes" which continue as long as the pendulum keeps on swinging. It is not known whether it has occurred to the inventors, but it is evident that if there were two or more calls on one bell and battery simply varying the lengths of the pendulums would give an easy means of indicating which circuit was calling. Our readers are not specially interested in grocery, but in view of next August we looked round the exhibition to see how things were done, and the arrangements appeared excellent.

A Welsh Thunderstorm.—If we may believe the *Daily News*—it is no mere local print which is responsible for the report—curious things happen in Wales after thunderstorms have been about. On Monday, "the Druids Temperance Hotel at Redruth was almost entirely destroyed by fire. The manager (Mr. Paul) was awakened about half-past five in the morning by the ringing of the electric bells in the house." After details of damage, it is added, "The cause of the outbreak is uncertain, but it is believed that a severe thunderstorm which passed over the town during the night had some connection with it, and the ringing of the electric bells is pointed to as supporting the theory that the electric fluid may have originated the fire." Whether this is believed in Bouverie-street, or only in Redruth, is not absolutely clear. It would no doubt have been a considerate act on the part of the thunderstorm after having done the mischief to give the alarm in this way, but it is just possible that an electric bell fitter—we will not say an electrician—might imagine a simpler way in which in the course of a fire the bell circuit would get completed and the bells start ringing. But then this particular storm was a remarkable one in other ways "The thunderstorm was so severe that a police constable was carried by some agency which he is unable to explain a distance of 30ft. from where he had been standing" Making all due allowance for a natural professional bias against believing unnecessary evil of electricity, we are still more inclined to think that it was a combination of wind and fright that moved that policeman rather than electrostatic attraction.

Meters in America.—In the course of an article in the *American Electrician* on the subject of electric meters, Mr. Thomas Duncan makes some curious observations Apparently the American customer can be made to understand what an ampere is, but a watt is beyond his intellectual grasp, or it is thought so. But there seems to be a preference for mere "lamp-hour" instruments. From the central-station point of view that would be quite comprehensible. The complete paragraph runs as follows: "If the meter be a lamp-hour instrument, the chances for checking by the consumer are without doubt the simplest and most easily understood. If he entertains any doubt

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in his mind as to its accuracy of operation, it is only necessary to keep a record of the number of lamps used during an evening and their time of use, or the number of hours they have been burning, when the product of these two quantities will give the reading of the meter. If it be an ampere-hour meter, it becomes necessary that he be made acquainted with what is meant by the unit 'ampere,' which can without much difficulty be explained to him so as to be intelligently understood. When a wattmeter is employed for measuring the energy, it is not quite so easy to make him understand what he is paying for, and in many cases a consumer has a disposition not to pay for anything he does not quite understand. This, of course, is natural, but yet I have heard central-station men express a desire for wattmeters, since the mere fact of their customers not understanding what a watt-hour is makes them less liable to check up the readings of the meter, as is easily accomplished with a lamp-hour meter."

Electric Locomotives.—It has been stated that an electric locomotive is to be tried experimentally on the lines of the Manhattan Railway Company, New York, in which the engine will carry a secondary battery, charged by current obtained from a third rail. The charge thus obtained will enable runs of 15 to 20 miles to be made over rails not electrically equipped. If experience in accumulator traction goes for anything, the advantage of this will hardly pay for the increased cost and the loss due to the double conversion. A locomotive of altogether a different type is described in the *Scientific American.* It is one constructed by the Baldwin Locomotive Works and the Westinghouse Electric Manufacturing Company. The locomotive is for the use of the Crozer Coal and Coke Company at Elkhorn, West Virginia, in the Pocohontas coalfield. It has six coupled wheels, and is capable of drawing 40 loaded cars up a 2 per cent. incline at a rate of six miles per hour, developing a draw-bar pull of 10,000lb. The track gauge is 44in., and the rails weighs 40lb. per yard. The locomotive will pass through an opening 6ft. 11in. high above the rails, 10ft. wide at bottom and 8ft. wide at top. There are two 100-h.p. Westinghouse motors, which are series wound, and may be operated either in series or parallel. The series arrangement is used for slow speeds, and the parallel for higher speeds. The motors are connected to driving axles by double-reduction gears. The average speed of the locomotive with the motors in parallel is stated to be six to eight miles per hour. The current is taken from an overhead line by a trolley arm, and the voltage is about 500.

Magnetic Units.—The New York *Electrical World* is apparently greatly disappointed that the Geneva Electrical Congress has not resulted in the adoption of the system of units advocated by the American Institute of Electrical Engineers. "As to the incomplete and hybrid set of units," says our contemporary, which were adopted by the British Association, "no apparent reason suggests itself for such action other than an attempt to antagonise as effectually as possible the desired aims of the American body." Without discussing the merits of the question one way or the other, it is perfectly certain that no thought of anything of the kind ever entered the minds of anyone on this side of the water. We are then told quite straightly what we are to do on this side of the Atlantic. "It remains for the British Association, a universally respected body, to reconsider the vote of last year, and to either propose magnetic units having some claim for superiority over those provisorily adopted by the American Institute of Electrical Engineers, or adopt the units which the latter has proposed. The aim to be strived for is universal agreement." Quite so; but in order to secure that, the authority of a body would be required which is much more truly representative of electrical science throughout the world than the Geneva meeting could claim to be. And although in some branches of electrical engineering the Americans have got the start of the rest of the world, so that we may reasonably go there to see what things may be done, and what dangers must be avoided, they have by no means such a pre-eminence in the theoretical part of the subject as would enable them to decide between the fancies of French and German experts, even if Great Britain stood neutral in the matter.

A Narrow Escape.—The following shows the way in which accidents may happen in America. It will be seen in the sequel that it was a barge that was smashed and not an electric tramcar, but it might very well have been otherwise. The Americans have a perfect right to fix their own standard of safety or unsafety where they think best, and work their railroads and tramways how they please. They may tell us it is no concern of ours; and some of them do pretty plainly. But in a way it is, for whenever anything goes wrong and makes mischief in America, it is used to discredit the introduction of electric traction in this country. The *Western Electrician* describes the occurrence to which we refer thus: "A curious accident occurred in Chicago the other day by which a trolley car was hoisted several feet in the air on the big hoist bridge at Halsted-street over the south branch of the Chicago River. The engineer saw a barge coming, or was notified by a policeman to that effect—the accounts are conflicting—and hoisted the bridge without waiting for the usual signal from the bridge-tender's tower. An electric car was on the structure at the time and was lifted with it to a distance variously stated at from 10ft. to 30ft. The motorman stuck to his post, but the passengers were alarmed and scrambled from their seats. The bridge-tender immediately sounded the signal to lower the bridge. This signal was obeyed, and this movement nearly crushed the barge, which had not cleared the bridge. Finally the boat got through, the bridge was restored to the street level, and the car resumed its strangely interrupted journey without injury to anyone. The fault is attributed to the engineer in acting without orders. The Halsted-street Bridge, which is of rather unusual construction, has attracted much attention from engineers. It has a direct vertical hoist said to be 212ft."

Municipal Management.—The *Street Railway Journal* likes the English and European ways of managing municipal matters better than the American one. In other words, the permanent official is better to work up to than the mere party nominee. The former implies a certain amount of "red-tape" and formality, yet under the European system "it is possible to push through great municipal improvements at an expense much less than that which is found necessary" in the United States. The benefits of a foreign system are often exaggerated and its defects not observed, but our contemporary is probably not far wrong in its conclusion that America has much to learn from Europe in the matter of the business management of municipalities. "Through centuries of experiment and by means of mistakes as glaring as those now committed in American cities there has been evolved in Great Britain and most of the Continental countries a system of municipal administration which is certainly economical and efficient in most cases, and is certainly far more scientific in principle than that found in general in this country. The especial feature of the European system is the selection of trained engineers of the highest character for the principal departments where engineering ability is required

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and for the higher positions, even up to the mayoralty, of men who have not only proven themselves good men of business, but who are fitted by special experience for the positions which they occupy. An administrative corps of this character is far superior to one selected for political reasons or whose members are mere accidents of the hour. Another point of advantage in the European system is the close interdependence of the various departments of a city, district and national government." But sometimes there is less difference between our local bodies and those of America than our contemporary imagines.

Rontgen Ray Work.—In the course of his inaugural address to the Pharmaceutical Society of Ireland Prof. C. R. Tichborne urged that pharmacists (in England, less accurately, we call them chemists) should make the taking of Röntgen photographs a part of their business. If the art became essential to successful surgeons it was evident that it must be at the disposal of every practising surgeon, where-ever he found himself and whatever the surrounding circumstances might be. But to suppose that every busy surgeon in country towns would maintain battery, coil, tubes, and photographic paraphernalia in working order was not at all likely. He might for a brief space, but when the emergency came he would find that he had not got his apparatus in order. Here the pharmaceutical chemist might step in, and for a moderate fee give him the revelation of the particular part he wants. Prof. Tichborne doubtless knows more about Irish surgeons than we do, but on the face of it we do not see why a surgeon should be less likely to have his tools ready when wanted than a chemist. Moreover, the latter would have to leave his shop to go to the patient, a matter to be considered in the fee and expenses. It is stated in a letter to the *Scientific American* that a very fair cryptoscope screen for Röntgen ray experiments can be made by coating a piece of pasteboard with prepared glue and sifting on a coating of common zinc white (oxide of zinc), which can be obtained very cheaply at any paint shop. As potassium platino-cyanide is never likely to be very cheap and the proper quality of calcium tungstate is not always obtainable in an instant, the suggestion may be worth testing by anyone who does not use a fluorescent screen habitually, but might find the occasional use of it helpful as a preliminary to exposing the sensitised plate. The behaviour of different fluorescing materials, however, depends very much on the current and tube used.

Society of Engineers.—At a meeting of the Society of Engineers, held at the Royal United Service Institution, Whitehall, last Monday evening, a paper was read by Mr. William G. Wales, A.M.I.C.E., on "Discharging and Storing Grain." Having drawn attention to the certain though irregular diminution of home-grown wheat in the United Kingdom, and to the steadily increasing dependance of the English nation upon external sources of supply, Mr. Wales stated that the adoption of grain-discharging machinery had not been very great considering the growth of the imported grain trade during the last quarter of a century, but referred to London and Liverpool as being the two great grain centres where the most modern improvements in this class of machinery were to be seen. Reviewing the various systems of discharging grain, the author first mentioned that carried out by means of a crane and a Priestman bucket or tub, and explained that this system was often used in England on account of the cranes being able to discharge grain in bags, or ordinary merchandise as well as grain in bulk. He next discussed the various kinds of grain elevators, pointing out that their duty was to dredge the grain from the hold of the ship, and to raise it some 20ft. above the quay. These are roughly divided into floating, fixed, and portable elevators. The use of a conveyor band for carrying the grain from the elevator into a warehouse was also referred to. Fixed elevators, which are generally mounted on derrick arms, had been made in this country large enough to discharge grain at the rate of 100 tons per hour, but they are more often only used for discharging grain in barges. Portable elevators were next discussed, and the author then made a few remarks on raising grain by means of compressed air and by suction. Apart from the first cost of these systems, their advantages were shown to be great, as all trimming of the grain in the hold of the ship was dispensed with. The paper concluded with a few remarks on the machinery for distributing grain in warehouses, and also on the respective merits of silos and floor granaries, and also their cost.

Telephones and Tramlines.—What with the British Association and other matters, the Geneva Electrical Congress has almost been forgotten by this time in this country. A somewhat longer reference than the exigencies of space allowed us to give at the time may, however, be made to the report of Dr. Wietlisbach, of Berne, to the congress on the subject of the disturbances in telephone lines produced by the working of electric trams. Obviously the first thing necessary is to find the principal seat or seats of the disturbing influence. A mere steady leakage of current would not affect a telephone; the cause of the noise might be sought in irregularities of contact with the rails (particularly if these are dirty) or with the trolley wire, or, again, it may be the motor might be in fault. It appears that the last supposition is in the main the correct one, for experiments showed that if the motor was replaced by a resistance, and the car run down an incline, the noise ceased, but if the car was lifted and the motor ran, the car remaining stationary, the disturbances continued. The conclusions arrived at by the congress—which for obvious reasons represent mainly German experience—are, briefly, that telephone lines can be protected sufficiently well against heavy currents by abandoning earth returns and using metallic circuits, and the heavy-current circuits should be so insulated and so placed with regard to telephone circuits that the currents passing to earth and the induction effects are reduced to a sufficiently small amount. For earthed circuits, like those for railways, the outgoing line and the apparatus connected with it should be well insulated. There should be insulated return wires, and, if necessary, there might be small "booster" dynamos in those circuits. The rails should be well bonded, transversely connected, and have special return feeders, and the motors should be so constructed as to produce as little undulation of the current as possible. At overhead crossings the telephone lines may be sufficiently protected with fuses when the voltage does not exceed 750, but with a higher voltage the heavy-current wires should be protected with guard wires which are well earthed, and have their earth connections tested continually.

Electric Railways.—The French Society of Civil Engineers in its *Bulletin* has published what is practically a treatise by Mr. E. de Marchena on electric railways. Mr. de Marchena reviews what has been done in tramway work, giving especial attention to American practice, and then goes on to railway work proper. The conclusion of the survey is that in the existing state of the electrical engineering industry the conversion of the French railways into electric lines would be perfectly possible, and that the expense of the work would be small in comparison with the amount of capital already sunk in the lines. The actual sum is put at something over £2,000 a mile. Mr. de Marchena, however, considers that the increased receipts and the reduction in working expenses which might be reasonably

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expected to follow the adoption of electric traction would more than cover the cost of interest and sinking fund on the capital necessary for the transformation, so that it would be an advantageous operation from a financial point of view. In a matter of this kind, where there is little or no past experience to go upon, probably no two men will bring out exactly the same estimate, and it must not be forgotten that Mr. de Marchena considers feasible the employment of current at a much higher voltage than has hitherto been used in tramway work. "It is well to remark," he says, "that since the introduction of electric traction there has been a continual tendency to increase the pressure. It was at first 200 to 300 volts, then 550 to 600, and now, on the Baltimore and Nantasket line, it has been carried to 1,700 volts." "Why," he asks, "must we stop at that? What prevents us going to 1,000, 2,000, or 3,000 volts?" The considerations of public safety are, he argues, quite different on a fenced railway, to which the general public has no access, from those which obtain on an ordinary street tramway, and the case of a broken wire can be met by the use of automatic circuit breakers. The continuous-current motor for these high tensions is a matter of more difficulty, but the author thinks that at 1,000 to 1,200 volts "the difficulty would not be very great." The saving in copper is obvious, but with every deference to Mr. de Marchena, a line to take a trolley is not quite the same thing as a power transmission line.

A Railway Proposal.—The Metropolitan Railway runs about as many trains as is possible, and at certain times of the day at any rate these trains are as full as they will hold; yet the dividend is not exactly of a satisfying character to the ordinary shareholders. On the other hand, it is useless to endeavour to get more traffic on the suburban branches than the line can carry into the City. To meet this state of things, it has been stated by the *Financial Times* that a syndicate has brought before the directors a plan for an electric railway from the City to Earl's Court below the existing line. It is added that "the members of the syndicate and their friends are said together to control over £1,000,000 of stock; and, naturally, when groups interested to this amount in so small a line as the District bring forward a scheme that, on paper, promises so much at so small a cost, the directors have little choice except to give careful attention to the matter. For £800,000, the syndicate tells us, we can have a brand new line, with an express service between the Mansion House and Earl's Court, two intermediate stopping-places being provided at Victoria and Charing Cross. Moreover, the syndicate is willing to pay all preliminary expenses of enquiry, and, in addition, the members of it are prepared to provide the money necessary for its construction, subject to a guaranteed interest to be fixed between 4 and 5 per cent." If we understand it correctly, it is intended to keep the present line for the all-round and local traffic, while the suburban trains would change their steam for electric locomotives at Earl's Court and run express by the lower line to the City. There would be many obvious advantages in this, and though immediately underneath an existing tunnel is not the cheapest place to build another tunnel, it must be remembered that by taking this course there is no land to be paid for, a consideration which in London may easily be paramount to all others. The position of the proposed additional lines makes the adoption of electric traction a necessity. Should the scheme ever be carried out there will be an opening for some contrivance in the way of an automatic signalling apparatus, as it is evident that although there are only two stations the line would require to be divided into more than three block sections on the ordinary plan. The scheme has, however, been at present discussed rather from a financial than an engineering point of view, and it is quite uncertain what form it may ultimately take. Should a later suggestion be adopted—namely, to suppress the station at Victoria and make all passengers change and go down lifts into the new electric line at Earl's Court—much of the convenience offered by the line would be lost.

Ether Waves.—The interchange of views at the British Association on the theory of the Röntgen radiations formed the subject of an article in our columns last week. One or two points, however, may be referred to. In the first place, it should be remembered that the Helmholtz theory of dispersion brought forward by Prof. J. J. Thomson is not a theory of the radiations, but only an illustration of how if the wave-length is supposed short enough there may be no refraction. Even if the particular and very specific relation between the luminiferous medium and the molecules assumed in that hypothesis were in a general way the true one, yet the actual phenomena would be much more complex. The main novelty, however, was Sir George Stokes's suggestion. In assuming some time ago that if Sir George abandoned a "periodic" hypothesis he had nothing left but a corpuscular one, the possibility that his theory might be one of solitary waves did not occur to us, since it did not seem clear how such waves, if of the same magnitude, would behave very differently from ordinary light waves. The theory of single waves is by no means so well known as that of the indefinite succession of similar undulations. What would happen of course depends on what assumptions are made as to the intimate structure of the medium, but it seems clear that if the change from one medium to another were sharp enough, such single waves would be reflected in the usual way. Moreover, although we have got into the habit of considering, for simplicity, a beam of ordinary unpolarised light to consist of an indefinite succession of similar vibrations, it is obvious that it cannot be so in fact, and the uniformity is only "statistical," and due to the circumstance that the smallest portions of space and time we can deal with are large in proportion to the dimensions of the waves. There should be contained in such light at least some series of a comparatively small number of similar waves. It is therefore still necessary to assume that the solitary waves are much shorter than the ordinary light wave, and it does not seem at present to matter much whether, when the average is taken, they are assumed to be solitary or "successive." There are, however, electrical reasons for thinking it probable that the number of vibrations of the originating source is in each case small. As to longitudinal waves, unless the writer has made a mistake—not a difficult thing to do in these matters—the mathematical difficulties in the way of the transmission of any serious amount of energy by longitudinal ether waves seem insuperable if the suppositions are made which are necessary to prevent results coming out which we know to be untrue. The experiments on the effect of the Röntgen radiations on the conduction of gases are very promising. The effect of a current seemed to indicate that the conduction was electrolytic, and that exposure to the rays formed ions in the gas. But the filtration experiments seemed to show that the ion of a gas is a large body, larger than an air molecule. This is, of course, quite contrary to what is usually supposed to be the case with the ions in a liquid electrolyte. Further investigation may supply a reason why so many of the physical constants which depend in any way on the theory of a gas come out very nearly, but not quite, what might be expected.

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RAILWAY BLOCK SIGNALLING.

BY J. PIGG.

(Continued from page 273.)

Another method of locking the block instruments with the outdoor mechanical signals is shown by Figs. 67-75, which illustrate Sykes's three-wire system, familiarly known as the S.Y.X. system. As in Winter's and Saxby and Farmer's systems, the principal object aimed at is the control of the starting, or advance, signal at the sending end of the section by the signalman at the receiving end, but it is distinguished for the extreme simplicity of the electrical apparatus and for its departure from the usual design of such apparatus.

The system provides a combined locking and indicating instrument for each line of rails, each instrument being provided with a separate line wire; separate bell communication between the ends of each section by which all signals other than those indicating the condition of the line

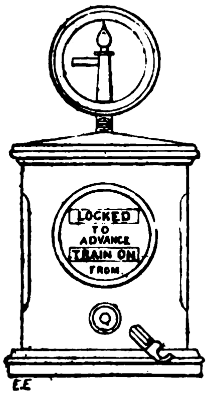

FIG. 67.—Sykes's Block Indicator.

for the time being are sent: a mercury contact rail treadle placed near the starting signal to release the locking arrangements at the proper time; and an automatic signal-arm replacer, fixed on the starting signal, which is also worked in connection with the rail treadle.

The general arrangement of the block indicator is shown by Fig. 67. It consists, as will be seen, of two distinct portions. The upper part containing the small semaphore arm constitutes the block indicator for one line of the *advance* section; whilst the lower part contains the mechanism for interlocking the instrument with the mechanical signal at that place, the electrical apparatus by which the mechanical signal at the *rear* cabin are released for use, and the indicators of the condition of the *rear* section of the same line. One portion of each instrument is, therefore, worked *from* the advance cabin, and the

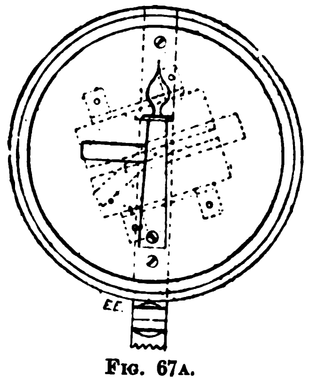

FIG. 67A.

other portion is worked *to* the rear cabin, and the indications of different parts of one and the same instrument give to the signalman information of the condition of both sections so far as one set of rails is concerned.

The construction of the semaphore indicator is shown by Fig. 67A. The position of the arm is horizontal when no current is passing through the coils of the instrument, and in this position the arm indicates the equivalent of "Train on line." When the section is clear of trains on the line of rails represented by the indicator, or of shunting operations at the receiving end of the section, the arm is held in a diagonal position by a permanent current, and indicates in this position the equivalent of "Line blocked." A reference to Fig. 75 will show that the position of the arm is controlled by the signalman at the receiving end of the section, and its indications are in no way dependent upon the actions of the man at the sending end of the section. Fig. 68 is a perspective view of the locking mechanism in

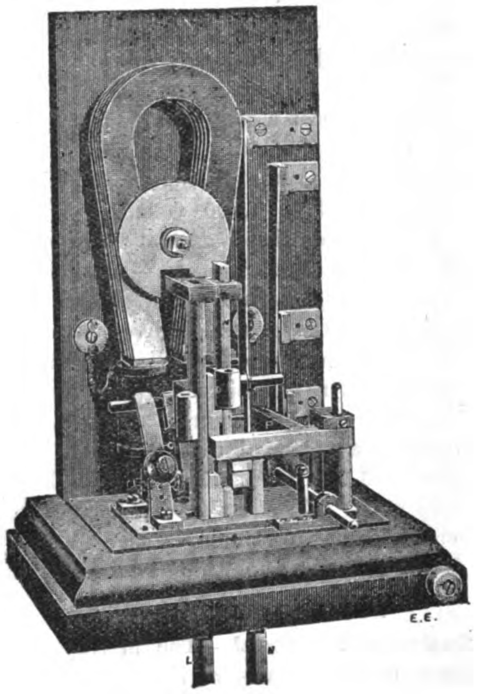

FIG. 68.

the lower part of the instrument. Fig. 70 is a front elevation, and Figs. 69 and 71 are left and right elevations of the same respectively, but the relative positions of the various parts of the apparatus are different in Fig. 71 to the positions the same parts occupy in Figs. 69 and 70. The apparatus consists of a plunger, P, actuated

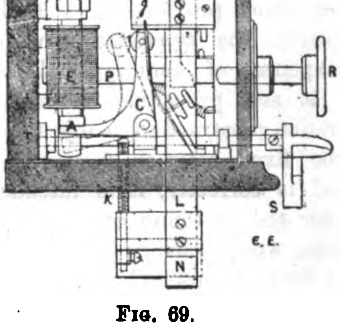

FIG. 69.

by the knob, R, the polarised electromagnet, H, a switch, T, the lock bars, M, *n*, O, and the rods, L and N, in connection with the starting signal mechanism. The plunger, P, at any block cabin makes connection between the spring, S^2, and the battery studs 1 and 2 (Figs. 70 and 75), and sends a current through the polarised electromagnet at the rear cabin in such a direction as tends to weaken the attraction of the permanent magnet upon the soft-iron armature. The armature, A (Fig. 69), is carried by one arm of a bell crank, C, the vertical arm of which

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carries a small friction wheel. A pin projecting from the vertical arm causes the latter to be acted upon by the strong spring, F (Fig. 70), which tends to separate the armature from the poles of the electromagnet. Under normal conditions A is held by the attraction of the polarised electromagnet, and the release is effected by passing a current of such strength and direction as will allow the spring, F, to overcome the diminished attraction of

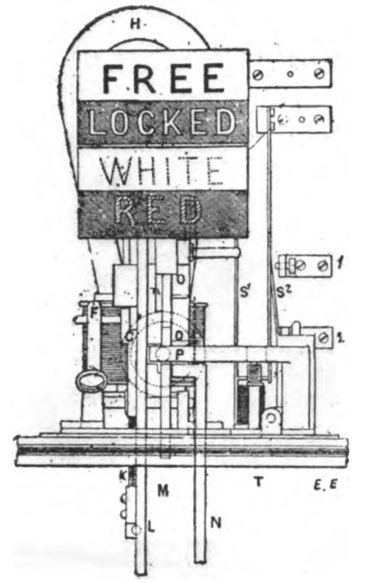

FIG. 70.

H. The switch, T, is used in connection with the one-cell battery shown in Fig. 75. This battery is used simply to hold the semaphore indicator at the rear cabin in the "off" position when the section is clear of trains on the line of rails it represents, and no operations involving the fouling of this line are being carried out. The lever, L, is pivoted at *c* (Fig. 72), and carries at one end of the arm the lock rod, *d*, for the signal lever, and at the other end the friction wheel, *b*. The continuation of L within the case of the instrument carries a light frame, on

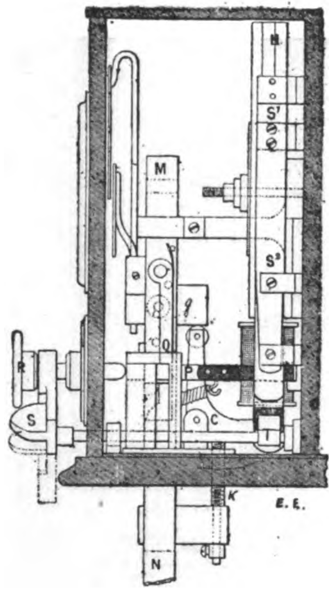

FIG. 71.

which is painted "free," "locked" (Fig. 70). These indications appear, in their proper order, at the upper opening of the instrument case, and indicate to the signalman the condition of the starting or other signal connected with L. Within the case L carries the projection, *g* (Figs. 69 and 71), which rests upon the friction wheel of C, as shown by the full lines in Fig. 69. Under the instrument L carries the parallel bolt, *k*, which, passing into the interior of the instrument, engages with the horizontal arm of C and raises the armature, A, into contact with H, when the motion imparted to L by the movement of the signal lever is upward. When the projection, *g*, rests upon the friction wheel of C the weight of L is supported by the latter, and the short arm pivoted at *c* (Fig. 72) is in such a position as to lock the signal lever in the "on" position. If the armature, A, is released L is lowered until the friction wheel, *b* (Fig. 72), rests upon the semi-circular rim of the double bell crank, and by doing so lifts the lock rod, *d*, into the position shown by Fig. 72 and releases the lever. At the same time the word "locked" disappears, and "free" takes its place at the upper opening of the instrument, indicating to the signalman that the lever is free to be placed in the "off" position. The tongue, *t* (Fig. 72), working on the same centre as the double bell crank, is loose, and works in a V groove on the vertical face of the crank. When the lever is placed in the "off" position *t* passes under the friction wheel, *b*, and raises L, and, in consequence, the armature, A, is raised into contact with the poles of H by *k* and held there. The word "free" disappears and "locked" takes its place at the upper opening of the instrument, indicating, in conjunction with the position of the signal lever, that the latter is locked in the "off" position. Consideration of Fig. 72 will show that this is really the case, and the signal lever cannot be fully replaced in the "on" position until the armature, A, has again been released. This release takes place when the train passes over the rail treadle near the signal actuated, and the word "free" again replaces "locked" at the opening in the instrument case. In replacing the lever in the "on" position, *t* again raises L and the armature. The latter is retained by H, and the former

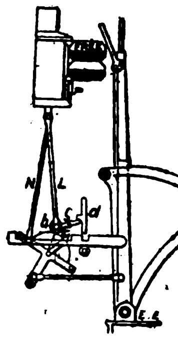

FIG. 72

by projection, *g*, resting on the friction wheel of C, and, so far as the electrical control of the signal is concerned, the apparatus is ready for a similar cycle of operations. The word "locked" again appearing at the opening indicates the locking of the signal lever in the "on" position. The slotted lock bar, M, carries on one side the swinging lever, O (Figs. 69, 70, and 71), and on the other side a second slotted bar, *n* (Fig. 70). As seen in Figs. 69 and 70, O is resting on the top of the rod, N, which is in the position it occupies when the signal lever is in the "on" position. If the plunger, P, is depressed under these conditions, the lever, O, is pressed back until it clears N, and the lock bars, M, *n*, O, drop into the position shown by Figs. 68 and 71 when the plunger is released. The mechanical result of this operation is to exhibit "Train on" at the lower opening of the instrument, and to place the slots of the lock bars, M *n*, in such positions, relatively to the plunger, that the latter cannot be again depressed until certain operations have been performed. The electrical results following the depression of the plunger are the breaking of the one-cell battery circuit by the fall of M (up-line instrument at "C," Fig. 75), and the consequent raising of the semaphore arm at the rear cabin to the horizontal position (up-line instrument at "B," Fig. 75), and the unlocking of the armature, A, at the rear cabin, by the current established by the contact of the spring, S^2, with the battery studs 1 and 2 (Fig. 75). A glance at Fig. 72 will show that when the signal lever is pulled into the "off" position, the rod, N, is drawn downward, and if the plunger has been previously depressed N will slide over the sloping face of O (Fig. 71), pressing it back meanwhile, until it reaches its lowest point, when O being free of N, again takes up a position imme

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diately over the latter. In replacing the signal lever in the "on" position, the upward movement of N raises M, *n*, and O into the positions shown in Figs. 69 and 70, when the plunger is available for use again. If it should be required to place the signal lever in the "off" position, without previous use of the plunger, as would be the case for a train issuing from a relief siding, such as is shown by Fig. 10, the lowering of N simply lowers M, *n*, and O into the position previously described, when, as before, the signalman is unable to depress the plunger in order to allow a train to leave the rear end of the section. It is evident therefore that a necessary condition of the use of the plunger is that the signal lever controlling entrance to the advance section shall be in the "on" position.

(To be continued.)

ELECTRIC GLOW LAMP TESTS.*

BY WILLIAM HENRY PREECE, C.B., F.R.S., ETC.

(Concluded from page 382.)

It will be seen that the only group which started at about its stated candle-power was Group G, of 3 to 4 watts per candle. This began with a mean candle-power of 15·56, and at the end of 1,000 hours' lighting reached an approximately constant candle-power of 12·5 per lamp. The watts per candle started at 3·57 per lamp and finally attained 4·7.

Group H, that of over 4 watts per candle, commenced with a candle-power of 13·43, and fell to about 10·5 in 1,000 hours, while the watts per candle varied from 4·5 to 5·6 per lamp.

Group F comprises high-efficiency lamps, and comes out somewhat unsatisfactorily, as the starting candle-power of the lamps is only 12·57. It should, however, be remembered that it consisted of three lamps only, hence a good mean result could not be obtained. During the 1,000 hours the candle-power fluctuated considerably, owing to new lamps taking the place of old ones, and at the end of this time it dropped to 7·82 per lamp, while the watts per candle throughout the time changed from 2·72 to 4·84. It will be seen in this case that at the end of 1,000 hours the so-called high-efficiency lamps required more watts per candle than those of Group G.

Sheet 3 graphically represents the lamps replaced in each group, expressed as a percentage at intervals of 100 hours taken from the following figures.

TABLE 7.—Percentage Number of Lamps Replaced.

Time. Hours.	Group H.	Group G.	Group F.	Remarks.
0	—	—	—	—
100	0	5·3	0	—
200	0	5·3	33·3	—
300	0	10·5	33·3	—
400	0	26·3	33·3	—
500	0	26·3	66·7	—
600	0	36·8	100·0	—
700	0	36·8	100 0	—
800	0	42·1	100·0	—
900	7·1	47·4	133·3	—
1,000	14·3	63·2	133·3	—

Group F = 3 lamps of initial efficiency = 2·3 watts per candle.
,, G = 19 ,, ,, ,, = 3·4 ,, ,, ,,
,, H = 14 ,, ,, ,, over 4 ,, ,, ,,

If the number of lamps in either group was sufficiently large, the curves on Sheet 3 after a time would become straight lines at different inclinations to the axis of time. The tangent of this angle denotes the rate of replacing the lamps with time. One hundred divided by this, when the constants for percentage of lamps and time are suitably taken, would therefore give the mean life of the lamps, since, at that time, all the lamps would have been replaced.

Thus in Fig. 2 :

$$\frac{y}{x_1} = \tan\theta, \text{ or } x_1 = \frac{y}{\tan\theta}.$$

$$\therefore \text{ Mean life of lamps} = \frac{100}{\tan\theta}.$$

Owing to the small number of lamps in each group the curves are not continuous, but it will be seen from Curve F in Sheet 3 that all the high-efficiency lamps are replaced in about 700 hours ; in the case of Curve G all the three to four watt lamps would be replaced in about 1,350 hours, and in the case of the low-efficiency lamps in Curve H there were only two failures out of 14 lamps after about 1,000 hours. It is therefore impossible to approximate the mean life of the lamps plotted in Curve H, but it can certainly be taken at considerably over 1,000 hours.

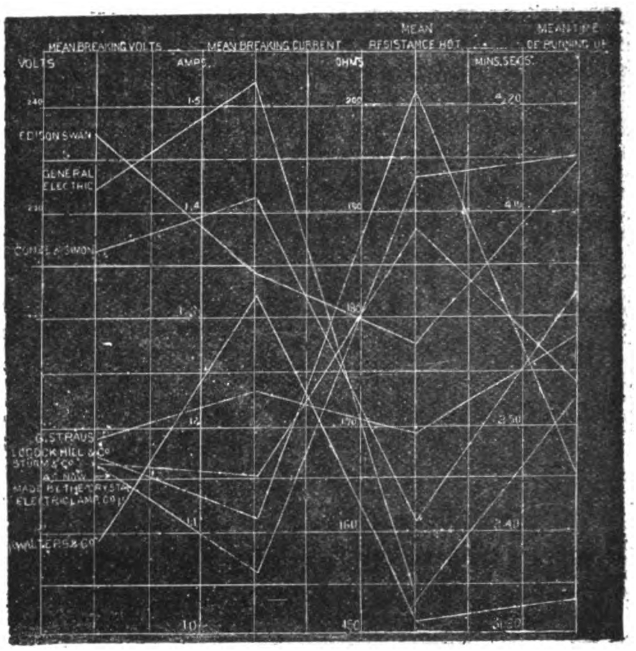


DIAGRAM TO TABLE I.

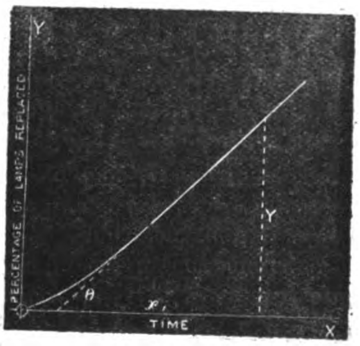
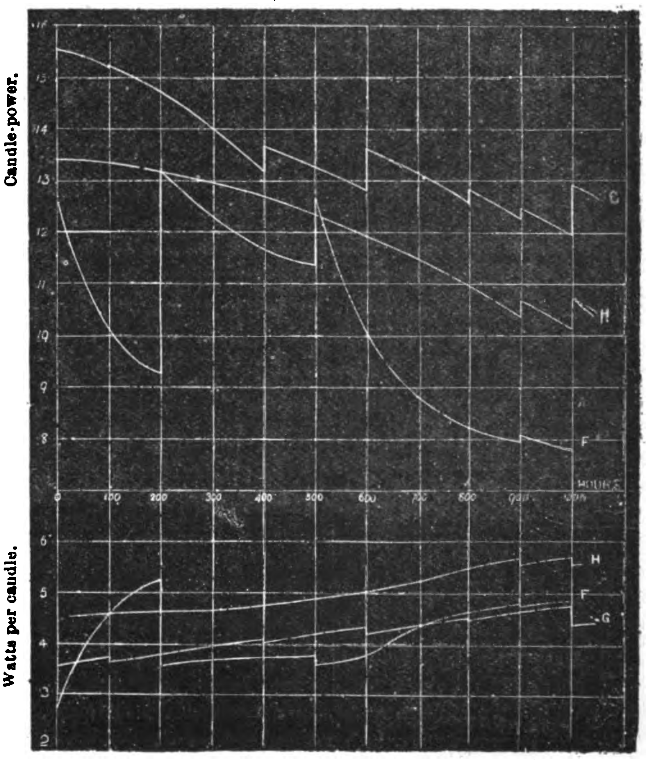


FIG. 2.



H, 14 Lamps of over 4 watts per candle.
G, 19 ,, ,, 3 to 4 ,, ,,
F, 3 ,, ,, 2 to 3 ,, ,,

CURVES CONNECTING TIME WITH C.P. PER LAMP AND WATTS PER CANDLE.—Sheet 2.

* Paper read before the British Association at Liverpool.

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TABLE I.—Behaviour of 105-Volt 16-c.p. Lamps on running up to Breakage Voltage.

Maker.	At starting.					At breaking.					Difference between starting and breaking.									
				Resistance.					Time of running up.		Volts.		Amperes.		Watts.		Resistance. Hot.			
	Volts.	Amperes.	Watts.	Cold	Hot.	Volts.	Amperes.	Resistance. Hot.	min.	sec.	Actual	Per cent.	Actual	Per cent	Actual.	Per cent	Actual. +	Actual. −	Per cent. +	Per cent. −
Edison-Swan (a)	105	·61	64·04	—	172·1	231	1·35	171·1	4	20	126	120	·74	121	247·81	387	—	1·0	—	·58
	105	·54	56·69	—	194·4	210	1·27	165·3	4	10	105	100	·73	135	210·01	370	—	29·1	—	15·0
	105	·56	58·79	—	187·5	255	1·41	180·8	4	20	150	143	·85	152	300·71	511	—	6·7	—	3·5
	105	·51	53·54	—	205·8	255	1·32	193·2	4	30	150	143	·81	159	283·06	529	—	12·6	—	6·1
	105	·57	59·85	—	184·2	235	1·34	175·3	4	5	130	124	·77	135	255 10	426	—	8·9	—	4·8
	105	·54	56·69	—	194·4	238	1·33	178·9	4	0	133	127	·79	146	259·81	458	—	15·5	—	7·9
				Ave	rage	237	1·34	177·4	4	14										
General Electric (b) ...	105	·69	72·45	—	152·2	225	1·59	141·5	4	0	120	114	·90	130	285·30	394	—	10·7	—	7·0
	105	·65	68·25	—	161·5	234	1·50	156·0	3	50	129	117	·85	131	282·75	414	—	5·5	—	3·4
	105	·66	69·30	—	159·0	225	1·42	158·5	3	50	120	114	·82	137	250·20	361	—	·5	—	·31
	105	·63	66·12	—	166·6	225	1·68	133·9	4	0	120	114	1·05	167	311·88	472	—	32·7	—	19·6
	105	·59	61·94	—	177·9	231	1·38	167·4	4	0	126	120	·79	141	257·82	416	—	10·5	—	5·8
	105	·63	66·12	—	166·6	252	1·55	162 5	3	35	147	140	·92	146	324·88	491	—	4·1	—	2·4
				Ave	rage	232	1·52	153·5	3	52										
G. Straus (c)	105	·46	48·50	—	228·2	219	1·13	193·8	3	45	114	109	·67	146	199·17	412	—	34·4	—	15·1
	105	·57	59·85	—	184·2	219	1·28	171·2	3	30	114	109	·71	125	220·40	368	—	13·0	—	7·0
	105	·49	51·44	—	214·2	180	1·38	130·4	3	45	75	71	·89	182	196·91	383	—	83·8	—	39·1
	105	·50	52·50	—	210·0	270	1·25	216·0	4	30	165	157	·75	150	285·00	343	—	6·0	—	28·6
	105	·49	51·44	—	214·2	180	1·24	145·2	4	0	75	71	·75	153	171·76	334	—	69·0	—	32·2
	105	·50	52·50	—	210·0	184	1·15	160·0	4	0	79	75	·65	130	159·10	303	—	50·0	—	23·8
				Ave	rage	208·6	1·23	169·4	3	58										
Stürm and Co. (d)......	105	·51	53·54	—	205·8	201	1·08	186·10	3	50	96	91	·57	112	163·56	305	—	19·7	—	9·6
	105	41	43·05	—	256·0	219	·83	263·8	3	30	114	109	·42	102	138·70	322	·78	—	3·0	—
	105	·56	58·79	—	187·5	201	1·32	152·2	4	20	96	91	·76	136	206·51	356	—	35·3	—	18·7
	105	·57	59·85	—	184·2	204	1·37	149·9	3	55	99	94	·80	140	219·60	372	—	34·3	—	18·6
				Ave	rage	206 2	1·15	188·2	3	54										
Conze and Simon (e)...	105	·60	63·00	—	175·0	225	1·42	158·4	3	30	125	119	·82	137	256·55	407	—	16·6	—	9·4
	105	·60	63·00	—	175·0	240	1·48	162·2	4	20	135	129	·88	147	292·10	464	—	12·8	—	7·3
	105	·58	60·89	—	181·0	225	1·38	163·0	4	5	125	129	·80	138	249·61	410	—	18·0	—	9·9
	105	57	59·85	—	184·2	219	1·40	156·4	4	10	114	109	·83	146	246·70	412	—	27·8	—	15·1
	105	·59	61·94	—	177·9	225	1·38	163·0	4	5	125	129	·79	134	248·56	401	—	14·9	—	8·3
				Ave	rage	226	1·41	160·6	4	2										
Lowcock, Hill, and Co. (f)	105	·51	53·54	—	205·8	225	1·08	208·3	3	35	125	129	·57	112	189·46	357	2·5	—	1·22	—
	105	·54	56·69	—	194·4	219	1·14	192·1	4	0	114	109	·60	111	192·91	340	—	2·3	—	1·18
	105	·49	51·44	—	214·2	228	1·13	201·7	3	50	123	117	·64	131	206·21	401	—	12·5	—	—
	105	·50	52·50	—	210·0	225	1·10	204·5	3	50	125	129	·60	120	195·00	371	—	5·5	—	—
	105	·50	52·50	—	210 0	219	1·10	199·1	3	30	114	109	·60	120	188·40	359	—	10·9	—	—
				Ave	rage	206·9	1·11	201·1	3	45										
P. Walters and Co. (g)	105	·57	59·85	368	184·2	221	1·20	184·3	4	0	116	110	·63	111	205·35	343	1	—	5·4	—
	105	·56	58·79	362	187·5	186	1·32	140·9	3	10	81	77	·76	136	186·71	333	—	46·6	—	24·9
	105	·57	59·85	363	184·2	183	1·42	128·8	3	25	78	74	·85	149	200·00	334	—	55·4	—	30·1
	105	·57	59·85	374	184 2	174	1 38	126·1	3	24	69	65	·81	148	180·25	301	—	58·1	—	31·5
	105	·56	58·79	364	187·5	258	1·31	197·0	4	0	153	146	·95	170	279·16	475	9·5	—	5·9	—
	105	·57	59·85	376	184·2	171	1·30	131·5	3	20	66	62	·73	128	162·50	272	—	52·7	—	28·6
				Ave	rage	198·8	1·32	151·4	3	33										
As now made by the Crystal Electric Lamp Company, Limited. (h) No. 7...	111	·46	51·00	384	241	216	1·20	180	4	30	105	94·6	·74	161	208·2	408	—	61	—	25·3
,, 10...	114·5	·39	44·66	460	293	219	1·03	212	4	15	104·5	91·2	·64	164	180·94	405	—	81	—	27·6
,, 11...	126	·41	51·66	440	307	180	1·00	180	3	50	54	42·8	·59	144	128·34	248	—	127	—	—
,, 12...	114	·46	52·44	390	248	195	1·09	179	3	45	81	71·0	·63	137	160·06	305	—	16	—	27·8
,, 13...	118	·41	48·38	464	287	210	·96	218	4	20	92	77·3	·55	134	153·22	317	8	—	—	24·0
,, 14...	119	·48	57·12	407	248	216	1·13	191	4	5	97	81·5	·65	135	186·99	327	—	25	—	23·0
				Ave	rage	206	1·06	193	4	15										

(a) Supplied April, 1895. (b) Supplied May, 1895. (c) Supplied September, 1894. (d) Supplied January, 1894. (e) Supplied September, 1894. (f) Supplied March, 1894. (g) Supplied March, 1894. (h) Supplied May, 1895.

From Sheet 2 it will be manifest that the lamps of from three to four watts per candle give the greatest candle-power per lamp—from 700 to 1,000 hours—with the least expenditure of energy per candle. To see which type of lamp was the most economical to use, the curves on Sheet H, connecting cost per candle-hour and time were calculated, as in the following Tables 8, 9, and 10, at intervals of 100 hours from the formula:

$$\text{Cost per candle-hour} = \frac{\text{The price of total number of lamps used.}}{\text{Total candle-hours up to that point.}} + \frac{\text{Mean watts per candle up to that point}}{1{,}000} \times \text{price of B.T.U.}$$

In the following Tables 8, 9, and 10, the cost per lamp has been taken at 1s. 3d. throughout.

In the instances taken an inspection of these curves show that even when the price per Board of Trade unit is as low as 3d. at the end of 1,000 hours, the high-efficiency lamp has to give way to those of Group G. The same remark holds in a less degree when the price of a Board of Trade unit was taken at 6d., but when the price of energy is raised to 9d. per unit the lamps occupy the relative positions indicated by their initial efficiencies, though there is not much difference between Curves G3 and F3. In this comparison, however, it must be borne in mind that the candle-power of the high-efficiency lamps was considerably under the normal at the start, and it is reasonable to expect that if the lamps as per Group F could be obtained, giving a mean candle-power of 16 at the start, they would be found to be more economical even when the price per unit is as low as

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TABLE II.—Behaviour of 105-Volt 16-c.p. Lamps, before and after running up to ¾ of Mean Breaking Voltage, set out in Table I.

Firm.	Before running up voltage.						At limiting voltage.				After running up voltage.						Percentage difference before and after increased voltage.										Remarks.
	Resist. Cold.	C.P. at 105 volts.	Amps. at 105 volts.	Watts.	Watts per candle.	Resist. Hot.	Volts.	Amps.	Resist. Hot.	Time of running up.	C.P. at 105 volts.	Amps. at 105 volts.	Watts.	Watts per candle.	Resistance. Cold.	Resistance. Hot.	C.P. +	C.P. −	Amperes. +	Amperes. −	Watt. +	Watt. −	Resistance. Cold. +	Resistance. Cold. −	Resistance. Hot. +	Resistance. Hot. −	
										m. s.																	
Edison-Swan	—	12·5	·51	53·54	4·24	205·8	180	1·14	157·9	2 40	12·7	·54	56·69	4·46	—	194·4	1·6	—	5·9	—	5·9	—	—	—	—	5·53	—
	—	11·4	·48	50·40	4·42	218·7		1·09	165·1		13·2	·53	55·6	4·21	—	198·1	15·8	—	10·4	—	10·3	—	—	—	—	9·42	
	—	14·5	·55	57·74	3·98	190·9		1·17	153·8		16	·61	64·04	4·00	—	172·1	10·3	—	10·9	—	10·9	—	—	—	—	9·85	
			Average		4·21					Average	13·9	—	—	4·22	Average		9·2	—	—	—	9·0						
General Electric.........	—	16·7	·66	69·30	4·15	159·0	174	1·12	154·4	2 40	22·8	·75	78·7	3·45	—	139·9	36·5	—	13·6	—	13·5	—	—	—	—	12·0	—
	—	19·7	·66	69·30	3·92	159·0		1·12	154·4		24·7	·75	78·7	3·19	—	139·9	25·4	—	13·6	—	13·5	—	—	—	—	12·0	
	—	16·9	·66	69·30	4·10	159·0		1·12	154·4		21·4	·75	78·7	3·68	—	139·9	26·6	—	13·6	—	13·5	—	—	—	—	12·0	
			Average		4·05					Average	22·9	—	—	3·44	Average		29·5	—	—	—	13·5						
G. Straus	421·7	8·4	·47	49·35	5·87	223·0	150	·73	205·5	2 30	9·3	·48	50·40	5·42	419·4	218·7	10·9	—	2·1	—	2·1	—	—	·54	—	2·06	—
	423·4	10·1	·47	49·35	4·88	223·0		·73	205·5		10·6	·48	50·40	4·75	420·0	218·7	4·9	—	2·1	—	2·1	—	—	·80	—	2·06	
	416·0	10·6	·48	50·40	4·75	218·0		·74	202·7		12·0	50	52·5	4·38	411·8	210·0	18·9	—	4·17	—	4·17	—	—	1·01	—	3·98	
			Average		5·16					Average	10·6	—	—	4·85	Average		11·5	—	—	—	2·79						
Stürm and Co.	349	11·03	·55	57·74	5·23	190·0	150	·84	178·6	2 30	11·49	·58	60·87	5·93	347	181·0	4·17	—	5·4	—	5·4	—	—	·51	—	5·19	—
	374	9·33	·57	59·85	6·41	184·2		·86	174·4		11·0	·59	61·94	5·63	373·4	177·9	17·9	—	3·5	—	3·5	—	—	·16	—	3·4	
			Average		5·82					Average	11 16	—	—	5·78	Average		—	—	—	—	4·4						
Conze and Simon	345	12·3	·57	59·85	4·86	184·2	168	1·1	152·7	2 50	15·6	·63	66·12	4·24	336	166·6	26·8	—	10·5	—	10·5	—	—	2·6	—	9·5	—
	340	13·1	·58	50·89	4·64	181·0		1·2	140·0		15·7	·64	67·2	4·28	330	164·0	19·8	—	10·3	—	10·3	—	—	2·94	—	9·4	
	350	11·2	·57	59·85	5·34	184·2		1·1	152 7		16·1	·64	67·2	4·17	337	164·0	43·7	—	12·3	—	12·3	—	—	3·71	—	11·0	
			Average		4·94					Average	15·8	—	—	4·23	Average		30·1	—	—	—	11·0						
Lowcock, Hill, and Co.	402·7	11·7	·51	53·54	4·57	205·8	168	·82	204·8	3 15	8·3	·52	65·1	7·84	407	201·9	—	29·1	1·96	—	1·96	—	1·06	—	—	1·89	—
	407	11·7	·51	53·54	4·57	205·8		·82	204·8	2 50	14·0	·53	55·6	4·68	406	196·2	19·6	—	3·9	—	3·9	—	—	2·4	—	4·6	
	406	12·1	·50	52·50	4·34	210·0		·80	210·0	2 20	13·5	·53	55·6	4·12	407	196·2	11·6	—	6·0	—	6·0	—	—	4·9	—	6·6	
			Average		4·46					Average	11·9	—	—	5·54	Average		15·6	—	—	—	3·95						
P. Walters	357	11·7	·58	60·89	5·20	181·0	150	·94	159·5	2 5	13·1	·58	60·89	5·26	358	181·0	12·0	—	—	—	—	—	·28	—	—	—	—
	387	12·7	·54	56·69	4·46	194·4		·90	166·6	2 15	13·3	·54	56·69	4·26	388	194·4	4·7	—	—	—	—	—	1·25	—	—	—	
	364	13·5	·57	59·85	4·43	184·2		·95	157·9	2 15	11·8	·56	58·79	4·98	364	187·5	—	12·6	—	1·75	—	1·75	—	—	1·8	—	
			Average		4·69					Average	12 7	—	—	4·83	Average		8·3										
		At nrml. vltg. of	Amps. at do.								Nrml. vltg.	Amps. at do.															
As now made by the Crystal Electric Lamp Company, Limited. B	439	115 / 13·5	·43	49·4	3·66	267	158	·69	229	2 30	14·9	·43	49·4	3·3	440	267	10·4	—	—	—	—	—	—	2·0	—	—	—
C	380	107 / 16·3	·48	51·4	3·15	223		·83	190	2 35	16·6	·49	52·4	3·2	380	218	1·8	—	2·1	—	1·9	—	—	—	—	2·2	
D	437	115 / 11·5	·44	50·6	4 40	261		·70	226	2 15	12·2	·44	50·6	4·1	435	261	6·1	—	—	—	—	—	—	·46	—	—	
			Average		3·74					Average	14·5	—	—	3·5	Average		6·1										

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3d., therefore, ignoring the inconvenience due to the large variations of the candle-power of separate lamps, these would be the most economical of the three types to use.

TABLE 8.—Cost per Candle-Hour.

Lamps of Initial Watts per Candle, 2 to 3.

Time hrs.	Total candle hours.	Watts per candle power (mean)	Cost per candle-hour.						
				Energy, B. T. U.			Total cost, B.T.U.		
			Lamps	At 3d	At 6d.	At 9d.	At 3d	At 6d.	At 9d.
			d.	d.	d.	d.	d.	d.	d.
100	1,129	3·64	·0132	·0109	·0218	0327	·0242	·0351	·0460
200	2.388	3·62	·0083	·0108	·0217	·0325	·0192	·0301	·0409
300	3,606	3·64	·0055	·0109	·0218	·0327	·0164	·0264	·0383
400	4,780	3·64	·0041	·0109	·0218	·0327	·0151	·0260	·0369
500	6,035	3 65	·0041	·0109	·0219	·0328	·0150	·0260	·0370
600	7,068	3·64	·0042	·0109	·0218	·0327	·0151	·0260	·0370
700	7,980	3·66	·0037	·0109	·0219	·0329	·0147	·0257	·0367
800	8,840	3·75	·0033	·0112	·0225	·0337	·0146	·0258	·0371
900	9,614	3·83	·0036	·0115	·0229	·0344	·0151	·0266	·0381
1,000	10,490	3·92	·0033	·0117	·0235	·0352	0151	·0268	·0386

TABLE 9.—Cost per Candle-Hour.

Lamps of Initial Watts per Candle, 3 to 4.

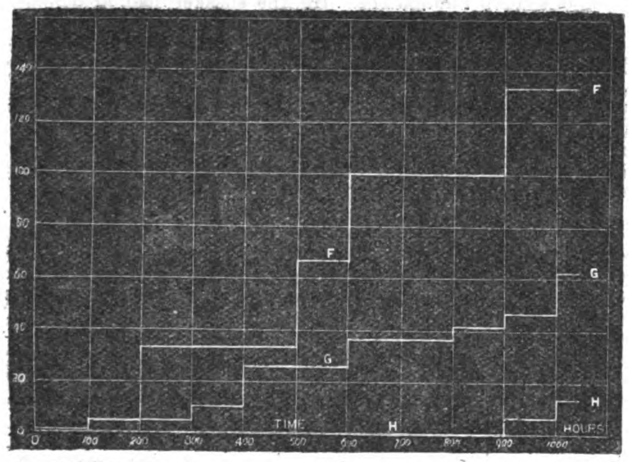
100	1,540	3·61	·0103	·0108	·0217	·0325	·0211	·0320	·0428
200	3,034	3·67	·0052	·0110	·0220	·0330	·0162	·0272	·0382
300	4,461	3·74	·0037	·0112	·0224	·0337	·0149	·0261	·0374
400	5,852	3·80	·0032	·0114	·0228	·0342	·0146	·0260	·0374
500	7,200	3·87	0026	·0116	·0232	·0348	0142	0258	·0374
600	8,574	3·91	·0024	·0117	·0235	·0352	·0141	·0259	·0376
700	9,905	3·97	0021	·0119	·0238	·0357	·0140	·0259	·0378
800	11,200	4·02	·0019	·0121	·0241	·0362	·0140	0260	0381
900	12,465	4·08	·0018	·0122	·0245	0367	·0140	0263	0385
1,000	13,760	4·10	·0018	·0123	0246	·0369	·0141	·0264	·0387

TABLE 10.—Cost per Candle-Hour.

Lamps of Initial Watts per Candle over 4.

100	1,338	4·53	·0112	·0136	·0272	·0408	·0248	·0384	·0520
200	2,660	4·55	·0056	·0137	·0273	·0410	·0139	·0329	·0466
300	3,963	4·58	·0038	·0137	·0275	·0412	·0175	·0313	0450
400	5,244	4·62	·0029	·0139	·0277	·0416	·0168	·0306	·0445
500	6,490	4·66	·0023	·0140	·0280	·0419	·0163	·0303	·0442
600	7,698	4·71	·0019	·0141	·0283	·0424	·0160	·0302	·0443
700	8,862	4·77	·0017	·0143	·0286	·0429	·0160	·0303	·0446
800	9,976	4·85	·0015	·0146	·0291	·0437	·0161	·0306	·0452
900	11,070	4·92	·0015	·0148	·0295	·0443	·0163	·0310	·0458
1,000	12,150	4·97	·0014	·0149	·0298	·0448	·0163	·0312	·0462

Lamps replaced (per cent.).

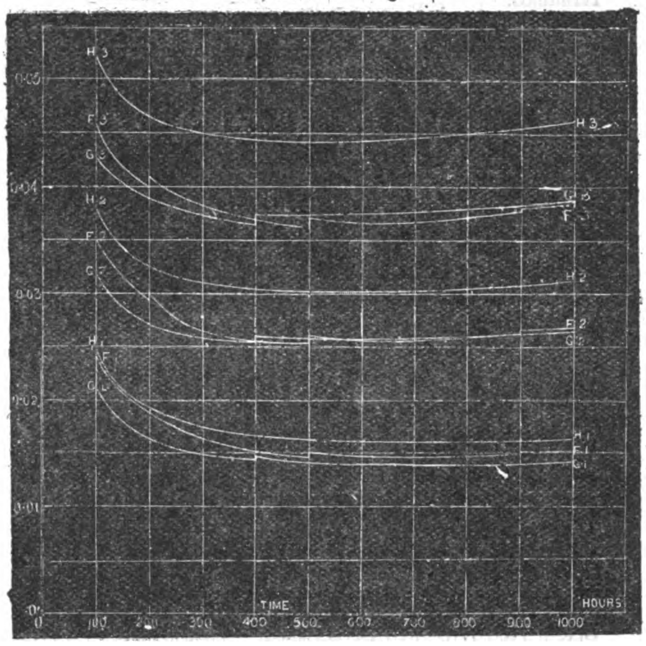


H, 14 Lamps, initial watts per candle over 4.
G, 19 „ „ „ between 3 and 4.
F, 3 „ „ „ „ 2 , 3.

CURVES SHOWING PERCENTAGE OF LAMPS REPLACED.—Sheet 3.

As compared with Prof. Ayrton's and Mr. Medley's excellent paper, I think the foregoing results based upon the greater number of lamps, lamps of different makers, and lamps of different efficiencies, furnish a more satisfactory idea of the cost per candle-hour, and also of the most economical lamp to employ. As regards high-efficiency lamps, if they could be relied upon to start at their marked candle-power, they would certainly be found of good service for domestic lighting and for large open spaces where a considerable reduction of candle-power of individual lamps would not cause inconvenience; but in large establishments like the Post Office, where each lamp must give a fairly uniform light over a long period, they could not be tolerated.

Cost per candle-hour in pence.



H, Lamps of initial watts per candle over 4. 1. B.T.U. at 3d.
G, „ „ „ from 3 to 4. 2. „ „ 6d.
F, „ „ „ „ 2 „ 3. 3. „ „ 9d.

CURVES CONNECTING COST PER CANDLE-HOUR AND TIME.—Sheet 4.

A copy of the present Post Office specification for glow lamps is given below. It is not yet regarded by me as being in its final form, but so far the conditions laid down have been satisfactorily met by certain lamp-makers, and this has resulted in a considerable improvement in the lamps supplied. We frequently find that weakness is apparent at the lamp mounts through the wires being too thin, and the joints between the metal and filament being defective.

Test No. 2, in conjunction with 1 and 3, has proved to be a valuable means of finding out the good, bad, and indifferent qualities of lamps; it is found to give a good forecast of what a lamp would do when used in the ordinary way, and may be regarded as equivalent to so many hundred hours' run. I also attach results recently obtained with some new two-watt lamps. The drop in candle-power with these lamps, as with all other economical lamps that I have tested, is very large during the first two to three hundred hours' run, after which time they seem to reach a steady state and behave like ordinary three to four watt lamps, but at this stage the illuminating power is no longer serviceable for post and telegraph work, hence the lamps would have to be frequently renewed.

These experiments have been tedious and exhaustive. They have been carried out under the indefatigable supervision of Mr. Isaac Probert.

MONTGOMERY LAMPS.

105 volts. B 4. Tests made July-August, 1896.

Hours run.	Candle-power.	Current.	Watts per candle.
0	27·7	·52	1·97
50	25·4	·52	2·15
100	17·9	·50	2·93
150	13·7	·48	3·68
200	13·0	·48	3 87
250	11·3	·475	4·41
300	11·1	·455	4·30
350	11·0	·465	4·44
450	10·6	45	4·46
550	10·5	·45	4·5
650	9·8	·44	4·71
750	9·0	·44	5·13
800	8·8	·44	5·25*

B 3. 105-volt lamp.

Hours run.	Candle-power.	Current.	Watts per candle.
0	21·1	·48	2·39
50	21·2	·485	2 40
100	18·7	·475	2 67
150	15·2	·465	3·21
200	13·8	·46	3·50
250	12·3	·455	3·88
300	12·3	·445	3·80
350	12·3	·445	3·80
450	11·1	·43	4·07
550	10·2	·43	4·43
650	10·2	·42	4·32
750	9·5	·42	4·64
800	9·0	·42	4·9*

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POST OFFICE TELEGRAPHS.—GLOW LAMPS.

TABLE REFERRED TO IN THE ACCOMPANYING SPECIFICATION, DATED JUNE, 1896.

Terminals.	Standard C.P.	Standard volts.	Test No. 1. Candle-power. Maximum.	Test No. 1. Candle-power. Minimum.	Test No. 1. Maximum watts per candle.	Test No. 2. Pressure raised to in $2\frac{1}{2}$ mins. Volts.	Test No. 3. Candle-power. Maximum.	Test No. 3. Candle-power. Minimum.	Test No. 3. Maximum watts per candle.	Test No. 4. Pressure raised to in 3 mins. Volts.
E. S. or B. C....	8	100 or 105	8·5	7·5	3·9	170·2	8·8	7·2	4·1	210
,, ...	8	110 or 115	8·5	7·5	3·9	174 6	8·8	7 2	4·1	215
,, ...	16	100 or 105	17	15	3·75	170·2	17·6	14·4	4·0	210
,, ...	16	110 or 115	17	15	3·75	174·6	17 6	14·4	4·0	215
,, ...	25	100 or 105	26·5	23·5	3·5	170·2	27·5	22·5	3·75	210
,, ...	25	110 or 115	26·5	23·5	3·5	174·6	27·5	22·5	3·75	215
,, ...	32	100 or 105	34	30	3·4	170·2	37	29	3·65	210
,, ...	50	100	53	47	3·3	—	—	—	—	—
Lug	100	105	106	94	2·9	—	—	—	—	—

105 Volts. No. 3.

0	16·2	·36	2·33
50	15·6	·39	2·62
100	14·1	·38	2·83
150	12·0	·355	3·11
200	11·1	·34	3·22
250	9·9	·34	3·61
300	9·5	·325	3·59
350	9·7	·335	3·63
450	8·6	·32	3·91
550	8·7	·32	3·86
650	8·25	·32	4·07
750	7·6	·32	4·42
800	7·42	·32	4·53*

* Lamp considered useless, so test discontinued.

POST OFFICE TELEGRAPHS.—ELECTRIC GLOW LAMPS.

SPECIFICATION referred to in the accompanying form of tender.

Size of Lamp and Terminal.—The glow lamps are to be to the size of a sample which is to be submitted for approval with the tender. In the case of lamps with screw holders, the screw terminal is to be strictly in accordance with a standard which will be supplied to the contractor, and to be of such a size that it can be screwed home in the Post Office standard gauge and accurately fitted.

Marking.—Each lamp is to have distinctly marked on the glass the voltage, the candle-power for which it is designed, and the maker's name, with the normal watts per candle-power.

Examination and Rejection of Broken or Defective Lamps.—Each lamp will on receipt be tested for continuity of circuit. All lamps having broken filaments, loose terminals, or which are otherwise of defective manufacture, will be rejected, and an equivalent number of good, sound lamps must be supplied free of charge by the contractors.

Lamps to be Selected for Test.—From the bulk of each delivery a number of lamps will be selected at random and tested electrically and photometrically. This number will vary according to the quantity delivered—viz., 3 per cent. of a delivery of 1,000 lamps or under, 2 per cent. of a delivery of 1,000 lamps and up to 3,000, and 1 per cent. of a delivery of over 3,000 lamps, will be tested. The Postmaster-General reserves the right to reject the whole delivery if more than 25 per cent. of the total number so selected fail to pass either or all the tests hereafter specified. If further tests are undertaken at the contractor's request, it will be at his risk and cost.

Tests.—The following tests will be applied to all the selected lamps: (1) A photometric test to determine the actual candle-power of the new lamp at its standard pressure, and an efficiency test to determine the watts per candle. The limits of candle-power and the maximum watts per candle-power allowable for each kind of lamp tendered are set out in the attached table. (2) After being so tested, the pressure at the lamp terminal will be gradually raised until it reaches in $2\frac{1}{2}$ minutes the pressure stated in Column 5 of the table. This pressure reached, the current will be at once turned off. (3) The lamps will then be retested, as described in test No. 1. The limits allowable for each kind of lamp as regards candle-power, and the maximum watts per candle-power, are set forth in the attached table. (4) In lieu of Tests 2 and 3 a proportion of the lamps not exceeding one-third of the whole number selected for test will be raised gradually in three minutes to the pressure stated in Column 7 of the table. The lamp under test must not fail in any way while the pressure is being increased from its normal voltage to that named in Column 7 of the table. (5) The candle-power of all lamps tendered for must be in terms of the English standard candle.

NOTE.—The Post Office measurements will be made with an improved Trotter photometer, and the standard of light will be either the Vernon Harcourt or the Hefner amyl-acetate, the former being taken for the purposes of this specification as one English candle, and the latter as ·88 of an English candle.

Signature of person tendering..........................

General Post Office. Date.......................

DISCUSSION.

Mr. H. Graham Harris asked what difference there would be in the lamps if alternating current were employed and how the specification would be altered to meet those conditions.

Prof. Ayrton said there was no question of the value of the investigations carried out by Mr. Preece. One of the things they wanted to know was the behaviour and life of the cheaper form of lamps which had been brought into this country, therefore the life tests were not only of importance to Mr. Preece and Post Office, but to all who were interested in electric lighting by means of glow lamps. He should like to hear how many lamps were used in obtaining the results given. For example, under Table Group A, it was stated that two lamps out of 24 of each make were selected at random, one 16 c.p. and one 8 c.p. Did that mean that tests were made on two lamps only, or were the results obtained from a large number? Tests in his (Prof. Ayrton's) laboratory had shown that unless a large number of lamps of a particular type were tried no results of any great value could be derived because of exceptional lamps of any particular make being extra good or bad. With reference to the breakage tests and running up the pressure to nearly twice, he thought if the results were borne out they were of very great importance. The least value that Mr. Preece had arrived at under the most favourable conditions was ·015d.; it ought to be borne in mind that even that most favourable result was a good deal higher, not lower, than lighting by gas with ordinary Argand burners, and was far dearer than gas with the Welsbach lamp. He had been recently carrying out life tests on a lamp which was not before the public, the filament of which was carbide of silicon. The speaker spoke eulogistically of this lamp, and added that after 1,000 hours the consumption was not higher than 3·75 watts per candle. He had been occupied in considering whether the candle-power rise was due to increase of vacuum, and had found by means of an induction coil that lamps in which the light improved was due to an improvement in the vacuum. Generally speaking, lamps in which the candle-power rose were incomplete; they were sold as complete lamps, but the filament gradually changed until the lamp was very much improved.

Prof. Fleming expressed surprise that Mr. Preece had adopted as his standard of comparison the standard candle on the Rumford method of shadow photometry. He, the speaker, had abandoned all forms of standard candle many years ago. The standard candle-power in the Act of Parliament and in the spermaceti were quite different matters. Photometry was not a question of instrument: it was one of observer, and for that reason he objected to all comparisons taken through red and green glass. What they wished to get at was the brightness upon a white surface as compared with the surface produced by a standard source of light. The Hefner lamp had been used a good deal in Germany, but was too red a standard, in addition to which there were difficulties in using it on account of ventilation. The Vernon Harcourt was a standard of very great value, and many observers had given it the first place. Mr. Preece had not referred to the standard, which was a modified platinum standard first suggested by Violle. In using an incandescent lamp as a secondary standard, there was a difficulty in measuring the rate of decay. He (the speaker) had adopted a method of using 16-c.p. filaments in large bulbs, and such secondary standards were exceedingly valuable. He should like to see in the first paragraph of the specification a more definite method suggested of placing the filament with respect to the photometer. Very little alteration in the filament would mean a variation of candle-power. He should like to see a final definition of the standard candle. At the present moment it was not sufficiently well defined. After referring to other clauses he suggested that the specification should be further discussed before final adoption, otherwise it might deal very differently with different classes of lamps.

Mr. Swan thought that the short test described in the paper was by no means a bad one, and very valuable information was derived from it. If the voltage was raised gradually during $2\frac{1}{2}$ minutes to 170 volts, and if the lamp did not break, he thought it strong evidence that the lamp is representative of a class, supposing it to be taken from a group of lamps.

Major-General Webber said in spite of the long monopoly and that the number of manufacturers had trebled since 1884, no one appeared to have thought it worth while to prepare a specification on behalf of the consumers. He thought that the specification would be an admirable document if minor alterations were made. Lamp manufacturers, however, he thought, had used all the

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methods of testing suggested by Mr. Preece. With regard to the specification, he remarked that if Mr. Preece could urge the makers to mark on the lamps, along with the other figures, the normal watts per candle, it would be of great use.

Mr. Preece, in replying, said it had been pointed out by Mr. Robertson that the alternating current had no different effect on the glow lamps. Prof. Ayrton had pointed out that though the cost of electricity was infinitely small, it was still greater than that of gas. Gas per hour was unquestionably cheaper than electric light; the economy of the electric light was not during the time it was burning, but one only used it when it was wanted. A gas burner was used twice as long as an electrical one. He suggested that if the Liverpool Corporation worked their trams electrically they could sell electricity at 3d. per unit. He should adopt the recommendations of Prof. Fleming with regard to the specification, and pointed out that new lamps which they had received had indicated upon them the watts per candle.

MEASUREMENT OF ELECTRIC CURRENTS THROUGH AIR AT DIFFERENT DENSITIES DOWN TO ONE FIVE-MILLIONTH OF THE DENSITY OF ORDINARY AIR.*

BY LORD KELVIN, J. T. BOTTOMLEY, AND MAGNUS MACLEAN.

The apparatus used in these experiments consisted of (1) a cylindrical tube 13cm. long and 1½cm. diameter, with two aluminium wires as terminals ground to points 1·5cm. apart; (2) a large Wimshurst electrostatic machine of 24 plates; (3) a high-resistance mirror galvanometer to measure the current between the aluminium point terminals inside the tube; (4) an electrostatic voltmeter to measure the difference of potential between the terminals of the tube; (5) a five-fall Sprengel pump, by means of which the density of the air inside the tube could be reduced to any desired extent. The galvanometer was placed on a block of paraffin between one terminal of the electric machine and one terminal of the glass tube. Its deflections were read by a telescope and its sensibility was arranged by external magnets, so that one division of deflection corresponded to 0·3 mikroampere. Our method of experimenting was to keep the density of the air constant while we varied the difference of potential between the terminals of the tube, and taking simultaneous readings on the voltmeter and on the galvanometer. The electric potential was varied either by varying the speed of rotation of the machine or by varying the distance between the needle-point terminals of the machine, or by a combination of both.

We found that at ordinary atmospheric density it requires a difference of potential of between 2,000 and 3,000 volts at the terminals of the tube before the galvanometer indicates any current. As the difference of potential is now increased, the current through the galvanometer increases at a greater ratio, so that if a curve be drawn with differences of potential as abscissæ and galvanometer readings or currents as ordinates, the curve is always concave towards the axis of current. Through this particular tube the currents at 3,000, 5,000, and 8,000 volts difference of potential were 7·2, 17·6, and 63·2 mikroamperes respectively. As the density of the air was diminished, the difference of potential necessary to start a current, as indicated by the galvanometer, gradually diminished also, till, at a density of about $\frac{1}{1000}$ of the ordinary density, a few score volts were sufficient to start a current. For the same difference of potential the current increased as the density of the air diminished; or otherwise, the same current was obtained by smaller differences of potential as the density of the air was reduced. Thus a current of about 56 mikroamperes was obtained by differences of potential of 7,400, 1,090, 700, 370, 405, 570 volts, when the densities of the air were 1 (ordinary density), 0·058, 0·0093, 0·0007, 0·00006, 0·000024 respectively; or otherwise, when the air pressures were 750, 44, 7, ½, $\frac{1}{22}$, $\frac{1}{55}$ millimetres of mercury respectively.

As the air density was still further reduced, the difference of potential necessary to start a current increased, and the current for the same difference of potential diminished. Thus, when the density of the air was reduced to one five-millionth of the density of air at ordinary atmospheric pressure and temperature, differences of potential of 3,000, 5,000, and 8,000 volts gave currents of 1·3, 4·4, and 14·6 mikroamperes respectively.

If a curve be drawn for a constant difference of potential, with air densities as abscissæ and currents as ordinates, we find the curve rising as the air density is diminished to about $\frac{1}{1000}$ or $\frac{1}{1500}$ of ordinary density; then falling again as the density is still further reduced to about a five-millionth of ordinary density. This is the lowest density we have experimented with, but we have no reason to doubt that at very much lower densities we would still be able to get measurable currents through the tube.

We are now experimenting with a tube 13cm. long and 1½cm. diameter, having ball terminals of ½cm. diameter and about 2mm. apart. The investigation is not complete enough for publishing any results.

* Abstract of paper read before the British Association at Liverpool

REOSTENE: A NEW RESISTANCE METAL.*

BY DR. HARKER AND MR. A. DAVIDSON.

Dr. Harker, of Owens College, Manchester, described some experiments made by Mr. A. Davidson and himself on a new alloy for commercial electrical resistances, which has been called "reostene." This alloy is the outcome of a number of experiments made with a view to find a material of a higher specific resistance than iron, capable of carrying heavy currents, and having only a moderate temperature coefficient. The average specific resistance of the material, as determined from a number of samples, is about 45-46 in terms of copper as unity, and in the specimens examined, which included strip and wire of various diameter down to No. 22 S.W.G., seems to be independent of the size of the wire.

The temperature coefficient of the wire was also determined for a number of samples. For these tests the wire was placed in an apparatus consisting of a cylindrical vessel holding about five litres of an insulated oil, which could be very rapidly stirred by means of a small double screw, placed in a side tube. This acted like a centrifugal pump, removing liquid very rapidly from below, and pouring it back on to the surface. The stirrer was actuated by a small Cuttriss motor placed on an adjustable stand, being coupled to the motor shaft by a piece of stout indiarubber tubing. The liquid could be heated either by means of steam blown through a spiral coil at the bottom of the vessel, or by a current passed through a German-silver wire, wound on a frame immersed in the liquid.

A number of specimens of wire of different diameters were examined in this apparatus, and gave almost exactly the same temperature coefficient ·0011 per ohm per degree Centigrade. This coefficient remains almost absolutely constant within the limits obtainable in this apparatus, 0deg.-60deg. Experiments made with wires in a small furnace at temperatures up to 500deg. C. showed a slight falling off in the coefficient above 100deg. The effect of current on the resistance of the wire was also tested. For this purpose pieces of the wire of 1 or ·1 ohm resistance were fastened by hard solder to copper rings which, by means of screws, could be attached to very stout copper leads and immersed in the bath previously described. Their resistance could be measured at a definite temperature, and they could then be removed, subjected to the treatment desired, and remeasured *at the same temperature under the same conditions.*

For all the resistance measurements a Carey-Foster bridge, designed by one of the authors for platinum thermometry, and recently described in a communication to the Royal Society, was used, and in the opposite arm to the coil was placed a Reichsanstalt manganin standard of negligible temperature coefficient. The resistance measurements were made to an accuracy considerably exceeding anything needed for the purpose of the tests, the last significant figure determined being omitted in the results given.

On treating various specimens of the wire with comparatively large currents only an extremely small variation was found in the permanent resistance. The first effect of the current is slightly to diminish the resistance of the wire, which on longer continued action gradually rose to somewhat above its original value. Selecting at random a specimen case, a coil of No. 14 S.W.G., after a current of 25 amperes had been passed for five minutes, decreased 1 per cent., but after the current had been again passed for four hours, during which time this wire was hot enough to char paper or wood, the resistance had increased to ·09 per cent. above its original value. Similar changes were observed in coils which had been kept for some days in the circuit of a motor, subjected to varying loads.

Only in the case of fine wires which had been heated to a full red heat could any serious change due to current be detected. Oxidation does not occur to any sensible extent below about 250deg. C. The material seems soft, and will stand a considerable amount of twisting force without injury or appreciable permanent alteration in resistance. Its mechanical properties seem only very slightly influenced by the passage of current.

A few tests made on the alteration in resistance of the material when embedded in a fireproof cement and carrying large currents also gave satisfactory results. The wire can be obtained from the makers, Messrs. W. and T. Glover, of Salford.

* Abstract of paper read before the British Association at Liverpool.

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THE OUTLOOK.

The meeting of the Brush Company, the remarks there made as to the trade of the year, the results of which were given in the balance-sheet, and those relating to prospective work, naturally lead to a closer examination of what has been and what may be. Of indicated work there has been no lack, of actual work there has been a fairly good amount, though all agree that a lull in demand has occurred; but most people think the period of depression to have passed. We doubt if the volume of trade has not all along steadily increased, but the increase was not so large as many sanguine people expected. We believe there are indications of a more rapid increase, but at the same time we are not sure that the work of any individual firm will increase in proportion. Before, however, discussing the reasons for such opinions, another matter referred to at the meetings of all companies may again be brought forward: it is the cut-throat policy followed by nine-tenths of those engaged in the industry. Work has been taken at unremunerative prices, and some of the big firms have been as bad or worse than the smaller ones. The result is well known to all the industry. Again and again has this cheap work turned out badly, and given such trouble that the engineers who have to bear the burden of other people's sins absolutely refuse to hear of, much less sanction, repeat orders when further apparatus is required. There is no reason why these things should not be said: they are "common knowledge" in the trade. The industry, then, has to thank itself for so narrow a margin of profit, and in many directions the margin is even narrower than those who imagine they know really understand. Many pieces of apparatus bear little or no profit for construction—only profit because of patent rights, which enables the factory to charge extra for patented details. A decided pinch will come to some of our manufacturers when these patents run out. We may now briefly state our reasons for thinking that though demand will increase, the business of existing firms may not increase in proportion. The principal reason is simply that more firms are entering the business, and the work will be spread among this greater number. There is now nothing particularly difficult to prevent the average mechanical engineer entering upon the construction of dynamos. The electrical or commercial efficiency to 2 or even to 5 per cent. will not appeal to the buyer. The calculations to be made are nothing compared with those a bridge designer or large roof designer has to contend with, and multitudes are able to make the simple calculations when only a few can make the more difficult ones. Hence our conclusion that with increased demand there will be an increase in the number of firms catering for the demand. Prices cannot be raised, and certainly they cannot be well lowered, for offers are continually being made as, we say, with a very small margin for profit. With regard to central-station work, one phase of the reason for the lull cannot be entered upon just now, but to anyone who carefully considers the history of central-station work and design one cause of the lull will become clear. However, that

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temporary lull has not been without its advantages, and authorities are beginning to approach the subject with a clearer conception of what they want and of what they must have. Without a doubt the engineers who originally advised the construction of certain central stations did not themselves realise the possibilities of electric lighting. Almost before a year had passed troubles arose from want of room for expansion. Local voters do not want, and will not tolerate, the excessively costly policy of hand-to-mouth construction, and in many places concerns three times as large might have been designed in the first instance. The initial constructional cost of buildings would have hurt nobody, and saved a lot of money and trouble in trying to run over-loaded plants till the extensions were ready. One or two designers in particular have largely adopted the policy of being, as they imagined, on the safe side, and erecting their stations with too little belief in the expansibility of the system. Local authorities who had not so early entered upon the work have seen this mistake, and have waited for a fair indication of what towns really require rather than to make two bites at a cherry. No doubt Mr. Ferranti's views of years ago were at that time as much too wide as some of these we refer to have been too narrow, but even in his case the reality would have been nearer the ideality had there been fewer unforeseen incidents of a disastrous character. As regards the views of many of the local authorities we are in a position to speak at first hand, and we know that more authorities than those whose names have at various times been indicated are seriously considering the question of establishing central stations. Unfortunately, in some cases delay in proceeding has arisen from the seriously conflicting statements of engineers consulted. Promise anything seems to be the established rule in some quarters, providing "I" can get the work. Geese with golden eggs for consulting engineers have been killed by these widely differing promises.

THE ANDREWS RETURN CURRENT CUT-OUT AND SYNCHRONISING SWITCH.

We were recently invited by Mr. L. Andrews to inspect the switching gear he has designed for the Hastings Electric Lighting Company, and the opportunity of seeing the alterations in this historical electric lighting undertaking we gladly accepted. We congratulate the engineer on his success in remodelling the generating plant. In the old days the consumers at Hastings were supplied with incandescent lamps grouped in series on arc lamp circuits. As this necessitated running a group of, say, 10 lamps or none at all, the inflexibility of the system of supply prevented the growth of the undertaking. The present plant in the station is run on the alternating-current system. The engines and alternators were supplied by the Brush Company, and the new supply is rapidly advancing in favour in the town.

After reorganising the arrangements for working the generating plant, Mr. Andrews turned his attention to the switchboard, and has succeeded in his endeavours to overcome several difficulties in alternate-current switching operations. His first idea was to prevent large currents passing when synchronising in case the incoming machine did not fall into step. To this end he designed a switch which would be automatically opened if the alternator began to motor. The switch, which is shown in Fig. 1, consists of two distinct sets of contacts. The first are placed in the porcelain vessels seen in the illustration, and are surrounded by water. The other contacts on the right-hand side are used to make the current only, and the

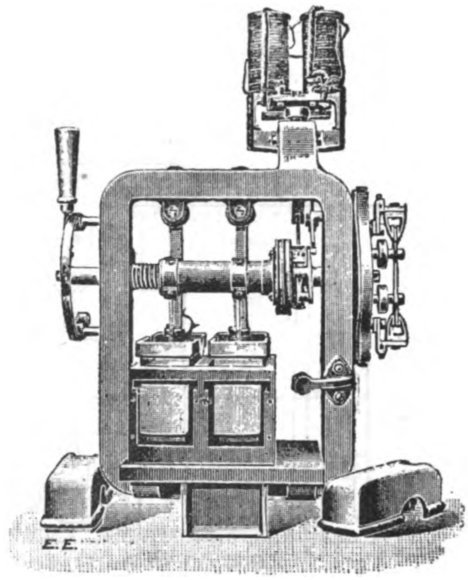

Fig. 1.

circuit is always broken under water. The operation of closing the circuit is as follows: The handle, to commence with, is in the vertical position. As it is pulled forward the right-hand contact is broken, and afterwards the two knives in the water-troughs are brought down into the corresponding jaws. This downward movement of the handle also raises a weight at the back of the switch, which engages with a small trigger under the controlling solenoids. The handle is then brought back

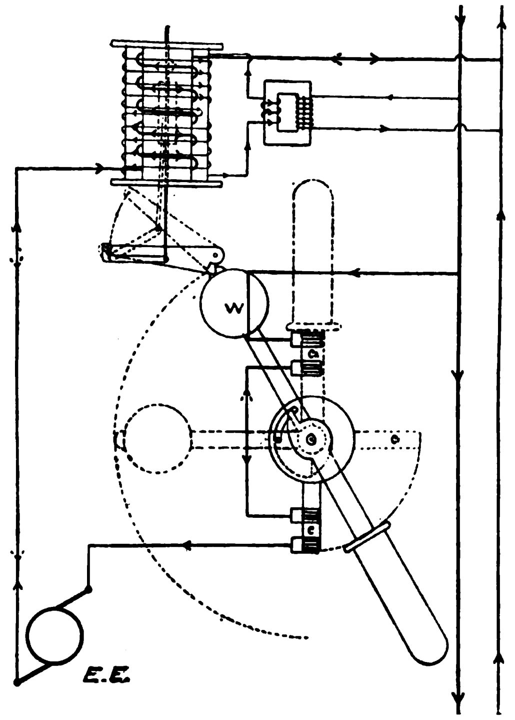

Fig. 2.

into the horizontal position. At this point in the backward motion it is found that the grip of the handle has to be changed. Having again taken hold of the lever, the remaining arc bringing the handle into the original vertical position completes the connection of the machine to the omnibus bars. Before the machine is thrown in the attendant watches the synchronising voltmeter But an error in judgment as to the correct time of throwing in is not serious, as the solenoids will then

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release the weight, which falling breaks the circuit. In the earlier types of this switch Mr. Andrews used two bobbins with iron cores and an armature. He wound these bobbins with two circuits, one supplied as a shunt to the omnibus bars, and the other in series with the machine. The shunt circuit was, of course, connected on to the secondary of a transformer supplied from the omnibus bars. The connections were so arranged that the magnetising action of the shunt coil opposed that of the main turns when the alternator supplied current to the omnibus bars. Hence, if a current for any reason passed back into the alternator, causing it to act as a motor, the magnetising effect of the two coils was added. The armature then is attracted, and the trigger releases the weight, allowing it to fall and disconnect the machine. The proportional effects of the two coils could, of course, be varied largely, and the switch would again cut out when the current in the main winding rose sufficiently high. The arrangement as above had two objections in Mr. Andrews's opinion. Firstly, if a short-circuit occurred on the mains, these automatic switches would cut the whole supply off before the fuses had time to act. In this way the faulty section would not be localised. The other fault lies in the fact that if the shunt circuits are from any accidental cause broken, the normal current in the main turns would be sufficient to actuate the switch. These two objections have been successfully overcome in the more recent types.

In the two switches seen at the left hand in Fig. 3 a single solenoid is used. The arrangement of the winding on the solenoid is shown diagrammatically in Fig. 2. It will be seen from this that the direction of winding of the shunt coils is reversed in the upper and lower valves. As the core is in its normal position held centrally in the solenoid, the magnetising effect of the shunt winding *per se* is nil. Hence, an accidental interruption of the shunt will not release the trigger. It will also be seen that the direction of the current in the main turns is the same as that in the shunt in the lower half of the solenoid. Thus, when the alternator is supplying current to the mains the core will tend to move downwards. The reversal of the alternator current will, however, produce directly the opposite effect. The shunt and main turns in the lower half will oppose each other, and their joint action in the upper half will lift the core. The actual pull in this case is not nearly so much as could be obtained in the earlier form of the apparatus. In order that this small force should with certainty release the heavy weight required to open the switch, Mr. Andrews has designed a neat compound system of levers, seen in Fig. 2. The action of this catch can be clearly seen from the figure, and it is surprising what a small force is required to release the weight.

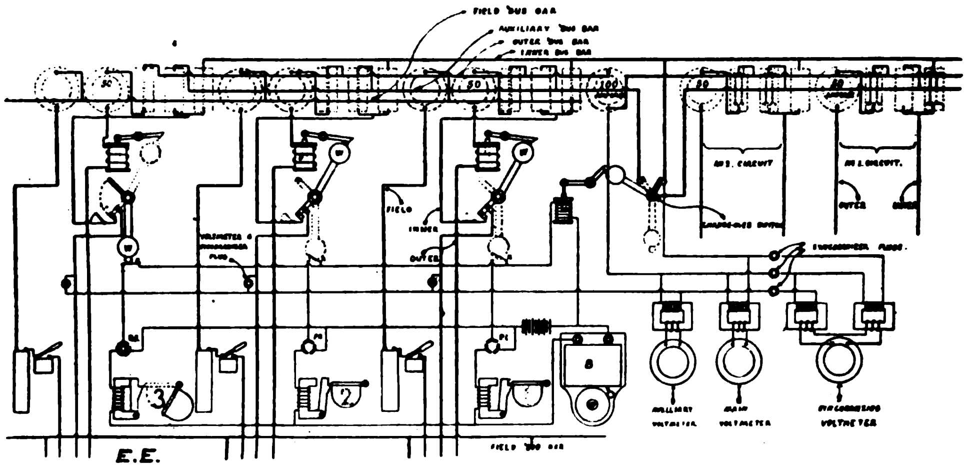

FIG. 3.

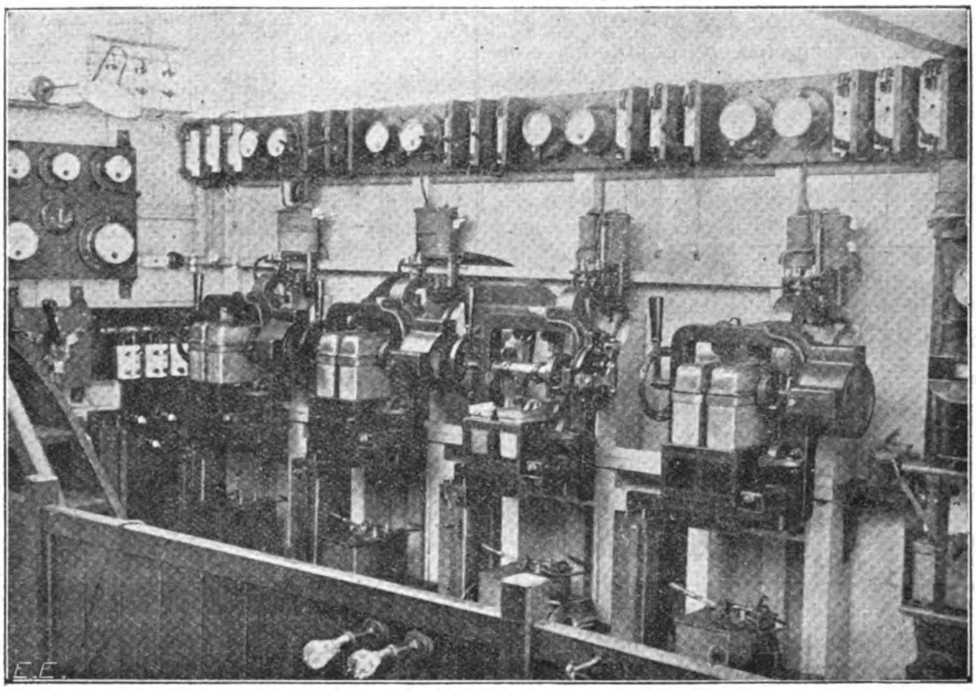

FIG. 4.

We were privileged to see these switches at work last week, and also to try them ourselves. A back current of from 10 to 15 amperes was quite sufficient to release the weight and break the circuit. The switch is, however, so easily reset that if on one forward oscillation of the synchronising voltmeter the alternator does not fall into step when switched in the switch can easily be thrown in again on the next forward swing. In this way repeated attempts to synchronise can be made without upsetting the

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supply voltage, and also unskilled attendance can be employed. In the switchboard at Hastings single-pole switches have been adopted, but it is only a matter of detail to make the apparatus double-pole. Mr. Andrews has also devised the following means for breaking up the load should a fault occur in one of the machines. Two sets of omnibus bars are provided, and at present two alternators in parallel supply the full load from one omnibus bar. Should, however, one machine develop a fault the load on the other would be excessive. Instead of waiting to parallel a spare plant before throwing out the faulty alternator it is run up on the spare omnibus bars to the correct voltage, and a certain proportion of the load is thrown on to it. This is automatically done by means of a relay actuated by the weight on the switch of the faulty alternator, which closes the relay circuit as it descends. The resultant flicker as the load is transferred from one omnibus bar to the other is hardly perceptible.

The whole connections of the switchboard as now arranged are shown in Figs. 3 and 4. A bell warns the engine attendant when this throw-over mechanism is to be employed, and the indicator also tells him which machine is coming out of parallel. These indicator and bell connections can be seen in the diagram, and give it a complicated appearance. The alternator connections, however, are most simple. In ordinary cases when the load decreases the synchronising switches are always used to break the circuit of the alternator to be shut down. It is then only necessary to regulate the stop-valve of the engine to shift the load on to the other machine, the circuit being immediately broken when the return current passes.

THE DIVISION OF AN ALTERNATING CURRENT IN PARALLEL CIRCUITS WITH MUTUAL INDUCTION.*

BY FREDERICK BEDELL.

A divided circuit with mutual induction between the two branches is shown in Fig. 1, being the same as a transformer with the primary and secondary circuits connected

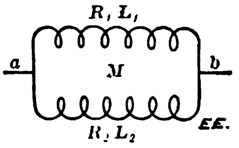

FIG. 1.—Divided Circuit with Mutual Induction.

in parallel. The E.M.F. equations for the two circuits are similar, the internal E.M.F.'s in each being equal to the same impressed E.M.F. The E.M.F. of mutual induction will be positive or negative according to the sense or direction in which the coils are connected. If the coils are connected as in Fig. 2, so that the ampere-turns of the two

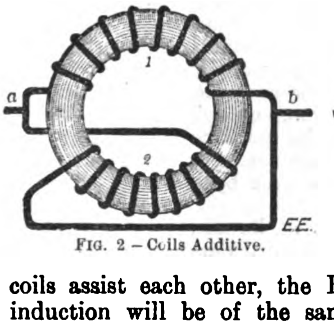

FIG. 2 – Coils Additive.

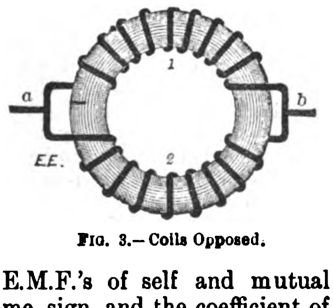

FIG. 3.—Coils Opposed.

coils assist each other, the E.M.F.'s of self and mutual induction will be of the same sign, and the coefficient of mutual induction will be positive. If the coils are connected so as to oppose each other, as in Fig. 3, the E.M.F. of mutual induction will be opposite in sign to that of self-induction. The coefficient of mutual induction may accordingly be + M or − M. Writing the E.M.F. as a function of the time, we have the following equations:

$$e = f(t) = R_1 i_1 + L_1 D i_1 \pm M D i_2 \quad . \; . \quad (1)\dagger$$

$$e = f(t) = R_2 i_2 + L_2 D i_2 \pm M D i_1 . \quad . \quad (2)$$

* Paper read before the British Association at Liverpool.

† D represents the operation $\frac{d}{dt}$.

By differentiation, the above equations become

$$f'(t) = R_1 D i_1 + L_1 D^2 i_1 \pm M D^2 i_2 ;$$

$$f'(t) = R_2 D i_2 + L_2 D^2 i_2 \pm M D^2 i_1 .$$

Eliminating i_2 by determinants, we have:

i_2	$D\, i_2$	$D^2\, i_2$	OTHER TERMS.
0	$\pm$ M	0	$R_1 i_1 + L_1 D i_1 - f(t)$
0	0	$\pm$ M	$R_1 D i_1 + L_1 D^2 i_1 - f'(t)$
R_2	L_2	0	$\pm M D i_1 - f(t)$
0	R_2	L_2	$\pm M D^2 i_1 - f'(t)$

= 0.

Cancelling out the first column and third row, as indicated by fine type, we obtain:

$$M^2 [\pm M D^2 i_1 - f'(t)] \mp M R_2 [R_1 i_1 + L_1 D i_1 - f(t)]$$
$$\mp M L_2 [R_1 D i_1 + L_1 D^2 i_1 - f'(t)] = 0. \quad . \quad (3)$$

From this equation the value for the current i_1 is obtained:

$$i_1 = \frac{R_2 f(t) + (L_2 \mp M) f'(t)}{(L_1 L_2 - M^2) D^2 + (R_1 L_2 + R_2 L_1) D + R_1 R_2} . \quad (4)$$

A similar expression is found for i_2.

For an harmonic E.M.F.

$$e = f(t) = E \sin \omega t ;$$

$$f'(t) = E \omega \cos \omega t .$$

Since $D^2 \sin \omega t = - \omega^2 \sin \omega t$, we may write $- \omega^2$ for D^2.

In equation (4) we may make these substitutions for $f(t)$, $f'(t)$, and D^2. By combining the sine and cosine terms into one term, and multiplying numerator and denominator by D, we have

$$i_1 = \frac{D E \sqrt{R_2^2 + (L_2 \mp M)^2 \omega^2} \sin\left(\omega t + \text{arc} \tan \frac{(L_2 \mp M)\omega}{R_2}\right)}{\alpha D - \omega \beta} \quad (5)$$

where $\alpha = R_1 R_2 - \omega^2 (L_1 L_2 - M^2)$;

$\beta = \omega (R_1 L_2 + R_2 L_1)$.

To free equation (5) from the operator D, perform the operation D as indicated in the numerator (by differentiating the numerator), and multiply numerator and denominator by $\alpha D + \omega \beta$. Substitute $- \omega^2$ for D^2 in the denominator and again perform the operation D in the numerator. We thus obtain an expression for i_1 which is free from D; this may be written in the following form:

$$i_1 = I_1 \sin (\omega t + \phi_1) . \quad . \quad . \quad . \quad . \quad (6)$$

where

$$I_1 = \frac{E}{\dfrac{\sqrt{\alpha^2 + \beta^2}}{\sqrt{R_2^2 + (L_2 \mp M)^2 \omega^2}}} . \quad . \quad . \quad . \quad (7)$$

$$\phi_1 = - \text{arc} \tan \frac{\beta}{\alpha} + \text{arc} \tan \frac{(L_2 \mp M)\omega}{R_2} \quad (8)$$

Similarly, for the current in the second branch,

$$i_2 = I_2 \sin (\omega t + \phi_2) \quad . \quad . \quad . \quad . \quad (9)$$

where

$$I_2 = \frac{E}{\dfrac{\sqrt{\alpha^2 + \beta^2}}{\sqrt{R_1^2 + (L_1 \mp M)^2 \omega^2}}} . \quad . \quad . \quad (10)$$

$$\phi_2 = - \text{arc} \tan \frac{\beta}{\alpha} + \text{arc} \tan \frac{(L_1 \mp M)\omega}{R_1} . \quad . \quad (11)$$

The ratio of the two currents is

$$\frac{I_1}{I_2} = \frac{\sqrt{R_2^2 + (L_2 \mp M)^2 \omega^2}}{\sqrt{R_1^2 + (L_1 \mp M)^2 \omega^2}} . \quad . \quad . \quad (12)$$

Their phase difference is

$$\phi_1 - \phi_2 = \text{arc} \tan \frac{(L_2 \mp M)\omega}{R_2} - \text{arc} \tan \frac{(L_1 \mp M)\omega}{R_1} . \quad (13)$$

Where the coils are opposed and nearly similar, the angle of phase difference between the currents depends largely upon the amount of magnetic leakage.

The diagram for the E.M.F.'s in a divided circuit in which the effects of self and mutual induction are additive is shown in Fig. 4. The two currents are I_1 and I_2 respectively, the main current being their vector sum I. In branch one O H is the power E.M.F. (in the absence of branch two); H J and J K are the E.M.F.'s of

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self and mutual induction, being at right angles to the currents I_1 and I_2 respectively. The corresponding E.M.F.'s for the second circuit are shown in the same diagram. The sum of the several E.M.F.'s in either circuit add up to E, the impressed E.M.F. Ordinarily, the branch current and the main current would lag behind the impressed E.M.F. by a large angle approaching 90deg. When the two circuits are identical, the branch currents, I_1 and I_2, would have the same magnitude and direction; the points H' and J' would coincide with the points H and J respectively. An inspection of the figure will

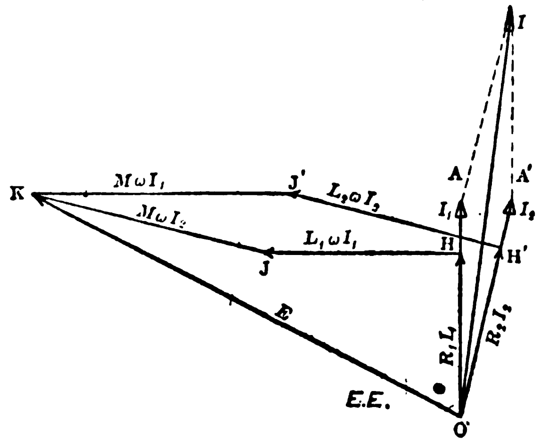

Fig. 4.—Coils Additive; *M* Positive.

show that for this case, in the absence of magnetic leakage, the effect of the mutual induction would be to double the tangent of the angle of lag. Fig. 5 shows the corresponding diagram for the case in which the E.M.F.'s of self and mutual induction are opposed. The current I_1 produces an E.M.F. H J in the first branch and J' K in the second branch, these E.M.F.'s being at right angles to the current, I_1, and opposite to each other in direction, on account of the sense in which the two coils are connected. Similarly, H' J' is opposite in direction to J K. The effects of self and mutual induction consequently tend to neutralise each other. The E.M.F. O K, required to cause the currents I_1 and I_2 to flow, is accordingly made less on account of the mutual induction, and would be reduced to the value of the ohmic E.M.F. in the case of two similar coils wound

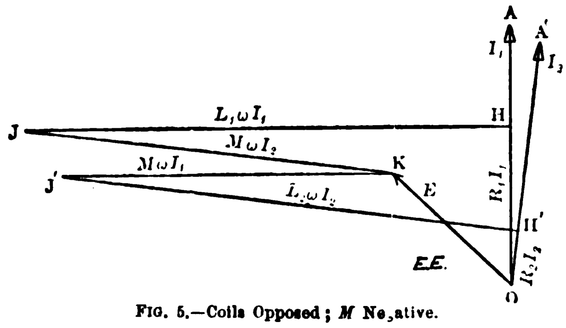

Fig. 5.—Coils Opposed; *M* Negative.

oppositely. In this case the angle of lag would be reduced to zero and the coil would be non-inductive. The equivalent resistance and self-induction for the two coils together, whether they are additive or opposed, may be found by resolving E into two components, one in the direction of the main current and the other at right angles to it. These components will be equal to R' I and L' ω I respectively. Their magnitudes may be obtained graphically, and from them the values of the equivalent resistance, R', and the equivalent self-induction, L'. The equivalent resistance and self-induction of either branch may be obtained in the same manner.

The conclusions relating to the special case of two identical coils wound without magnetic leakage, stated above in connection with the graphical construction, may be reached by substituting in the formulæ the values $R_1 = R_2 = R$; and $L_1 = L_2 = \pm M = L$. Also, $\beta \div \alpha = 2 L \omega \div R$. The two cases are as follows:

When M is Positive.—When M is positive, the coils being wound in the same direction,

$$\phi = -\text{arc tan}\frac{2 L \omega}{R} + \text{arc tan } 0 = -\text{arc tan}\frac{2 L \omega}{R}. \quad (14)$$

The current in each branch is

$$I_1 = I_2 = \frac{E}{\sqrt{R^2 + (2 L \omega)^2}} \quad . \quad . \quad . \quad (15)$$

For this case, therefore, the effect produced is the same as though the mutual induction were zero and the self-induction of each circuit doubled, the tangent of the angle of lag being doubled and each current being diminished accordingly.

The main current is

$$I = I_1 + I_2 = \frac{2 E}{\sqrt{R^2 + (2 L \omega)^2}} = \frac{E}{\sqrt{\left(\frac{R}{2}\right)^2 + L^2 \omega^2}} \quad (16)$$

which is the same that would flow in a single coil with the same self-induction and half the resistance as either branch.

When M is Negative.—When the coils are identical and opposed,

$$\phi = -\text{arc tan}\frac{2 L \omega}{R} + \text{arc tan}\frac{2 L \omega}{R} = 0; \quad (17)$$

$$I_1 = I_2 = \frac{E}{R}. \quad . \quad . \quad . \quad . \quad . \quad (18)$$

Each coil acts in this case as though non-inductive, the magnitude of the current being in accordance with Ohm's law, and the angle of lag being zero.

Cases where the two coils are not identical may be treated by substituting particular values for the resistance and coefficients of induction in the general equations.

APPLIED ELECTRO-CHEMISTRY.*

BY JAMES SWINBURNE.

LECTURE III.

Removing Tin from Scrap.

As sheet tin has from 3 to 5 per cent. of pure tin, it is clear that if all the scrap could be collected and have its tin taken off, the process would be very valuable. Tin is a very expensive metal, worth, say, £80 a ton. If scrap tin is worth £1 a ton, £100 worth would contain £240 worth of tin, and the iron or steel would be worth considerably over £100. The presence of tin makes scrap tin useless as iron, but if it is completely removed the scrap can be worked up into good quality iron. My attention was specially attracted to tin by an inventor who came to me with a patent for stripping it. As the patent he owned seemed useless I worked out another process. This was not electric, and consisted in dipping the scrap in baskets into fused caustic. If old tins were used this also melted out the solder, and corroded labels and varnishes so as to get at and remove the tin under them. The resulting stannate of soda was to be sold in that state, as it is a marketable chemical. The scrap coming out of the fused caustic had a good deal of the caustic sticking to it. It would, on a large scale, therefore be washed in successive baths, getting weaker and weaker, and ending in water; the liquid being gradually moved up into the fused vat to replace that removed as stannate. By this means the expense of evaporating down all the caustic that adhered to the tin could be kept down. This process works fairly well, but it is difficult to get the caustic to take up enough tin. The stannate thickens it very quickly, and the resulting mixture never contained enough stannate to be a commercial article. The tin could be easily removed from the caustic by electrolysis, and came down well.

This process seemed fairly promising, but at this stage it was found it had been tried before. A company had been formed to work it. Whether that company is now flourishing or not I do not know. As a matter of fact the process is probably quite old, as it is fairly obvious, and the skinning of scrap tin has exercised a great fascination for inventors for years.

As it was of no use going on with an old process, another method was sought. Acid electrolytes attack the iron as well as the tin, and were therefore out of the question. Curiously enough, if sheet tin is used as anode in caustic soda solution, the tin does not go into solution; oxygen comes off. I had tried a number of experiments in 1882 with sheet tin as backing for peroxide plates in alkaline solutions for secondary batteries. If sheet tin is boiled in caustic lye the tin is not attacked. If clean iron is dropped in, bubbles of hydrogen come off the iron, and tin goes into solution. Strangely enough, however, this process does not act, because very soon the clean iron gets coated with tin, and

* Cantor lectures delivered before the Society of Arts.

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the action stops. It is very odd that tin should be eaten off one piece of iron and then deposited from the solution on to another piece. This gave the key to the electrolytic process. All that is needed is to heat the caustic bath. The anode no longer gives off oxygen, and the tin is stripped off perfectly and deposited nicely on the cathode.

This process seemed perfectly successful; the next thing was to try it commercially. There are supposed to be thousands of tons of scrap tin wasted every year. It is said to be largely used for mending roads. When we tried to get it none was forthcoming; and it seems as if the whole idea of there being an important industry in the recovery of tin from scrap is erroneous; the difficulty is to get the scrap. Makers of large tin goods sell their clippings to people who do smaller work, and, finally, the scrap is distributed in such a way that it cannot be collected profitably. The recovery of tin and lead from old cans might be carried on on a very small scale by corporations, but it is questionable if it would pay, owing to the quantities available. This is an illustration of the principle that the great difficulty of the inventor is to discover a long-felt want.

Aluminium.

It would be of little use, even if there were room for it, to write a long description of the manufacture of aluminium by the various electrical processes, as full accounts of the works at Niagara, and to some extent of the Swiss and French, as well as the English works, have frequently gone the round of the technical journals.

It is very difficult to know what place aluminium will ultimately take in commerce. It is first to be a marvellously strong, light, and cheap metal, practically indestructible, and combining all the good points of all other metals; then it is run down as being soft, treacherous, easily corroded, and only useful in a few overrated alloys. The truth, of course, lies between these extremes. It is now becoming more generally realised that aluminium has really a very great affinity for oxygen, even at ordinary temperatures. The only reason why it does not combine with the oxygen of the air quickly enough to catch fire seems to be that the coating of oxide formed is very adherent and hard, and protects the metal. At the same time, it is exceedingly thin, and so transparent that the metal shows a beautiful polish, though the surface is really covered with a crust of alumina. The presence of this thin crust is shown by the difficulty of getting solder to take on to it. The coating of alumina also makes it difficult to make electrical contact with aluminium unless enough force is used to abrade the metal and expose a new surface. I have utilised this property in connection with the telephone used as a galvanometer in a Wheatstone bridge or potentiometer. The telephone circuit is made and broken by scraping a wire over a piece of sheet aluminium. This is far more easily heard than the scraping of a wire over the teeth of a file, or anything of that sort. No doubt the copper wire only occasionally breaks through the coating of alumina, and makes a short contact which is soon absolutely broken by the coating of insulating alumina again. If mercury is placed on aluminium, and the aluminium scraped so as to expose a clean surface to the mercury, the mercury amalgamates it. The amalgam, however, cannot protect itself by an adherent coating of alumina, and the oxide forms in light growths of fluffy alumina. If a drop of fairly strong amalgam of alumina is left exposed to the air, the oxide will grow from the surface of the mercury into a thing like the "Pharaoh's Serpent" which children make by burning sulphocyanate of mercury, when their parents are foolish enough to let them. Caustic alkali, or any acid that dissolves the alumina, will corrode aluminium. Another old experiment which shows the coating of oxide is due to Farmer, who fused a piece of aluminium wire by means of an electric current, and found it kept its form as a perfectly flexible and mobile conductor, which could be deflected by a magnet, and so on. On pricking the wire with a needle the melted aluminium ran out from the inside. This experiment shows that even melted aluminium, which appears beautifully bright and remains clear like silver, is really protected by a surface film of alumina.

The action of dilute acids, such as nitric and sulphuric, is very curious. Though aluminium does not deposit from the nitrate or sulphate in an electrolytic cell, hydrogen coming off instead, it is not at all quickly dissolved in dilute acid. I tried to make use of this property in an electrolytic meter for alternating currents. Two plates were to be employed in dilute acid, the aluminium going into solution at the anode during each half-period, without being deposited at the cathode. No sample of aluminium that I could obtain was acted upon little enough by the acid when there was no current, for such a meter to be accurate within commercial requirements.

Commercial aluminium loses greatly by being impure. Very slight traces of impurity spoil the metal. Commercial aluminium contains traces of silicon, sodium, carbon, and of other metals such as iron. A ½ per cent. or so of sodium is quite a common impurity and may do great harm. It may not be diffused equally throughout the mass, but may be segregated. This not only makes the metal non-homogeneous, and provides veins or flaws of weak metal, but on passing from sodium to aluminium every grade of alloy from nearly pure aluminium to nearly pure sodium is traversed, and some of these alloys are certain to be brittle. Sodium must also have a great tendency to cause corrosion. Not only does sodium oxidise in air and decompose water, but the hydrate formed itself dissolves alumina and attacks aluminium, forming sodium aluminate.

It is questionable if the contamination by sodium can be avoided in the electrolytic processes. There must be sodium present in the electrolyte, and the amount that goes into the metal must be rather a matter of current density and of the strength of the electrolyte in aluminium. Such impurities as carbon and silicon give trouble, not only because they alter the character of the metal, but because they are strongly electronegative to aluminium; and when they are exposed in small particles they form little local couples and give off hydrogen, thus allowing the neighbouring surface to be oxidised. It would probably make a very great difference in the value of aluminium if it could be purified further. Ninety-nine per cent. aluminium is already a commercial product, but it would be worth much more if it were 99·9 or 99·99 per cent. of aluminium. There is a great opening for a cheap and efficacious method of refining this metal further. There are rumours of such a process recently brought out or set to work in Paris, but no particulars are to hand yet.

(*To be continued.*)

COMPANIES' MEETINGS AND REPORTS.

BRUSH ELECTRICAL ENGINEERING COMPANY, LIMITED.

The annual general meeting of this Company was held on Monday at the Cannon-street Hotel, E.C., Mr. J. B. Braithwaite, jun. (the chairman of the Company) presiding. Notice had also been given for a special meeting to follow the general meeting in order to consider a reduction in the ordinary share capital of the Company.

The directors' report and the balance-sheet of the Company were published in our last week's issue.

In moving the adoption of the report, the **Chairman** said he was glad to see a large number of shareholders present to listen to the explanation he had to give of the result of the past year's trading. Of course, the results appeared to the shareholders and to the general public to be rather disappointing. To some extent the directors shared that view, but when he had given the explanation he had to make with regard to the circumstances met with during the past year they might be inclined to take a somewhat less pessimistic view of the immediate position and prospects of the Company. To put the thing in a nutshell, the gross trading profit for the past year had been £33,298, showing a reduction of £4,600 as compared with that of the previous year, but this amount, in turn, had been reduced to £2,900 by the economies which had been effected in the expenditure. During the past year they had not received a single large central-station order, and the whole of their profit had had to be made up on comparatively small orders, there having been no large contracts out in the past year. In the previous three or four years they had had a good share of the large contracts then made for the lighting of central stations for municipalities, but it seemed as if other municipalities, though unwilling to let anyone else take the work out of their hands, were waiting to see the result before they themselves embarked any large amount of capital in the electric lighting enterprise. Therefore, in view of the fact that during the past year the Company had not received a single large central-station order, he did not think the result so bad as might possibly have been anticipated, because the whole of the profits for the year had to be made out of orders small in individual amount. In the four previous years they had had an exceptional share of the large contracts for the lighting of central stations for municipalities, and executed orders for the municipalities of Leicester, Worcester, Hanley, and a good many others; but at the present moment there were very few orders of that type in the market. They had, therefore, had to depend entirely on a comparatively speaking retail trade—small orders of £1,000, £2,000, or £3 000—and it took a good many such orders to make up for the dearth of large block orders, and it spoke well for the appreciation in which their manufactures were held that, under the circumstances, the net profits only showed a reduction of £2,900 as compared with the previous year. The second debenture stock which had been issued this year amounted to £76,770. This stock had been made redeemable at the Company's option. Certain large Continental firms had approached them on the subject, and they at length accepted an offer that was made to them to purchase their Vienna business. This had put a large amount of capital into their hands for which they had no immediate employment, and the directors had, therefore, acted wisely last year, when raising this additional capital, to give themselves the opportunity of redeeming it should circumstances render it desirable. Their indebtedness to creditors and on bills payable had been reduced during the year to £33,585, which was less by about £11,300 than the amount shown a year previously. The loan from their bankers had been reduced from £78,097 to £26 775 at June 30 last, and it had since been further reduced to £10,000. It would, he expected, be shortly reduced to a merely nominal sum. The profit and loss account stood this year at £4,615; last year it

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stood at £7,541. Turning to the other side of the balance-sheet, it would be seen that under the first item they had during the past year been able to arrange what had long been desirable—viz., to get the item of property, patents, and goodwill divided up. Before they had no means of doing so accurately, because when the Company was formed they purchased the undertaking of the Anglo-American Brush Electric Light Corporation and of the Falcon Engine and Car Works for certain payment of shares, which included the whole purchase, and they had no means of dividing the item. To have divided it up in a haphazard way would have been worse than useless. The only possible basis on which they could divide it with anything like certainty was to obtain the services of one of the best-known firms of valuers. They therefore got Messrs. Fuller, Horsey, Sons, and Cassell to make a full and complete valuation. These gentlemen spent two or three months at Loughborough, carefully going through the whole of the works, buildings, and plant and loose tools, and in providing a complete and detailed valuation and inventory of everything the Company possessed there. He did not take any very sanguine view of the value of patents, and had never been a party to paying large sums for them. The only sound method of dealing with patents was to repay the inventor the actual out-of-pocket expenses, and let him depend for his future remuneration upon the results of the sale of his patent articles. If the thing was valuable he got paid. At the same time, it would be a mistake to suppose that the Company owned no good patents. On the contrary, although some of the original patents which the Anglo-American Brush Company bought for large sums in 1876 and 1877 had naturally now run out, yet they had constantly been bringing out and developing new patents, and at present they held in England something like 32 patents of an important character, many of which were bringing in a large volume of orders. In addition, they had a considerable number of foreign patents. Continuing on the subject of the accounts, the Chairman said the difference between what was owing to the Company and what they owed themselves last June represented an amount in favour of the Company of about £85,000. Last June, too, they had in cash £28,714, in addition to the £61,900 then due to them on account of the sale of the Vienna factory. These two sums amounted to £90,614, against £3,910 at the same period a year ago. The shares and debentures held by them in other companies amounted to £61,236 last year, compared with £56,454 this year. Owing to the sale of their Vienna business they had not thought it necessary to publish this year a separate balance-sheet for their foreign branch, and the shareholders were therefore now able to see in one balance-sheet the whole of the assets and liabilities. The valuation which had been made by Messrs. Fuller, Horsey, Sons, and Cassell showed that they had an item for patents and goodwill amounting to £206,000 on which they were expected to earn dividends, but which nevertheless represented nothing directly of a revenue-earning character. Their patents were of great value to them in their business, and the value of their goodwill was also shown by the orders they received; but he did not like to see such an item, however valuable it might be, standing at a large sum in the balance-sheet. The proposal which the directors had made to write off £1 a share on the ordinary shares would enable them materially to reduce the item of patents and goodwill, while it would not diminish by a single penny the amount of dividend which the ordinary shareholders would receive, because whether their shares stood at £2 or £1 they would be still entitled to the whole of the profit earned by the Company after paying the debenture interest and the preference dividend. At the same time, it would, he believed, make the balance-sheet very much sounder. They had felt it wise in connection with this proceeding to extract items under the headings of "stock," "debtors," and "shares and debentures," amounting together to £55,439. None of this amount, however, was known to be actually bad at the present time, or it would have been provided for in the profit and loss account; but, in view of the proposed reduction of the ordinary share capital, they had thought it wise to make provision which would ensure the distribution in subsequent years of the profits they might earn. They intended to keep an ample working cash balance in hand, which was necessary in a company like theirs. Since the financial year closed they had obtained one contract to the value of over £50,000, and such a contract as this required a large amount of working capital to deal with. There was also a considerable demand for the new "Universal" engine which Mr. Raworth, the company's engineer, had invented. Now, however, that the amount due to them on the sale of their Vienna factory had been paid, he thought they would take steps shortly to reduce the amount of the second debenture stock to a round sum of £50,000. He could not forecast what the result of the present year's trading would be, but he might inform them that for the first three months of the current year (to the 30th ult.) the orders they had received were for rather more than double what they were for the corresponding period of the previous year. The outlook, therefore, was very much better, but, of course, it was impossible to say whether it would be equally good for the remaining nine months of the year. With the strong financial position they were now in, and with all their manufacturing facilities, they ought to obtain a very considerable share of the large amount of business which would arise in this country in connection with electrical traction. They were in a position to undertake traction contracts for the entire job, instead of the work being divided among several firms. They hoped great things of electric traction, but it was necessary to exercise a good deal of patience before the matter came into practical working. English people did not rush into things so rapidly as Americans, but now, after a whole year has been spent in negotiations, they had this order of over £50,000, and there were other orders which were likely to come in the present year, so that electric traction would, he hoped, be a source of considerable profit to the shareholders in the near future. Mr. Braithwaite concluded by formally moving the adoption of the report.

Mr. B. H. Van Tromp seconded the resolution, and a considerable amount of discussion followed.

In reply to a **Shareholder**, who enquired whether a director could hold his qualification in preference as well as ordinary shares, the **Chairman** said that the qualification could be held in either class of shares. It would be remembered that the shares were originally £5 ordinary shares, which were divided afterwards into £2 preferred and £3 deferred. The holdings of the directors, however, were largely composed of ordinary shares.

The other **Directors** also stated that they were holders of more ordinary than preference shares.

Mr. Smart criticised the apparent smallness of the gross and net profits during the year.

The **Chairman** said that that he had never pretended that the directors were satisfied with the trading of the past year, and if they thought there was no future for the electrical industry it would be discouraging to go on with such a narrow margin. At the same time, they had done the best they could, and if the shareholders were not satisfied with their efforts they would have an opportunity of electing two new directors in place of those who were retiring. The Company was in a very different position to what it was when he joined the Board; it had now excellent works at Loughborough, with every facility for manufacturing, besides having the large sum of £90,000 at the bankers.

A **Shareholder** asked why they were now proposing to pay back preferential dividend, when it was not cumulative?

The **Chairman** explained that they were now only paying a small sum which had been overpaid to the ordinary shareholders, but which should have been paid on the preference shares. He added, in reply to questions, that the Company held a large stake in the County of London Electric Lighting Company, and the Board expected, if they could hold them long enough, the Company would reap a handsome profit. They also had a considerable holding in the Otis Elevator Company, having an arrangement with that company to manufacture their lifts at the Loughborough works. In reply to a suggestion that the Board should undertake pioneer work, the Chairman said such work had been done in the past, and was responsible for part of the suspense account.

After some further discussion, mostly in reference to the proposal to be made subsequently to reduce the capital, an amendment was proposed and seconded, "That the report and accounts be adopted, with the exception of Clause 9 of the report," but on being put to the meeting was lost, and the original motion adopted, with few dissentients.

A resolution for the payment of the balance of dividend to the preference shareholders having been carried, the retiring directors (Messrs. J. B Braithwaite, jun , and Mr. B. H. Van Tromp) were unanimously re elected, and the auditors (Messrs. Cooper Bros. and Co.) were also reappointed.

The meeting was then made special to consider the following resolution—namely: "That the capital of the Company be reduced from £750,000 divided into 150,000 preference shares of £2 each (of which 90,000 have been issued), and 150,000 ordinary shares of £3 each (of which 90,000 have been issued), to £660,000 divided into 150,000 preference shares of £2 each and 180,000 ordinary shares of £2 each, and that such reduction and alteration be effected by cancelling paid-up capital to the extent of £1 per share on each of the 90,000 ordinary shares which have been issued and by reducing the nominal amount of the said 90,000 ordinary shares from £3 to £2 each, and by subdividing the 60,000 ordinary shares of £3 each, now remaining unissued, into 90,000 ordinary shares of £2 each."

This was moved by the **Chairman**, who said, as to the method proposed, that as the preference and ordinary shares ranked *pari passu* in the case of a liquidation the ordinary shareholders would be in a less favourable position in that event, which, however, they regarded as a problematical and remote possibility, whereas if they had proposed to reduce the ordinary and preference shares *pro ratâ*, which they could have done under the articles of association, an immediate hardship would have been inflicted on the preference shareholders by cutting down their dividend, and there would be a strong opposition.

Mr. A. Sanderson having seconded the resolution, in the discussion which followed a considerable amount of time was occupied in explaining the proposal clearly to some of the shareholders. Some dissatisfaction was shown with the idea of reducing the nominal value of the shares, and the legality of the course taken was questioned. Counsel's opinion (Mr. Palmer) having been read on this point, a suggestion was thrown out that the matter might be deferred for a year. It being explained that one result of this might be that the profits to be earned in the ensuing year might possibly not be available for dividend, a second suggestion was made by **Mr. Fry**, who, with several others, considered that it might be advisable to adopt a different scheme, which would include the preference shareholders. This practically amounted to the appointment of a shareholders' committee to confer with the Board on the subject.

Ultimately, a division was taken on the resolution with a view to adopting this course if the resolution was lost. The directors did not vote, and on counting the body of the meeting it was found that there were 38 for the resolution and 14 against. As a three-fourths majority is requisite for a resolution of this character, this meant that the proposal was lost.

The **Chairman** then called on Mr. Fry to nominate his committee.

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Mr. Fry refused to do this, saying it was for the directors to propose a scheme which would be more equitable as between the two classes of shareholders.

The **Chairman** said the Board had done their best in the matter, and could not come to any other conclusion than they had done.

Matters being thus at a deadlock, it was suggested that the votes should be counted over again, the directors present voting. To this **Mr. Fry** raised no objection, saying that if on further consideration he thought it necessary he could raise the matter again at the confirmatory meeting. Upon the show of hands being again called for there were found to be 41 for the resolution and only 10 against. The resolution was therefore carried, the **Chairman** remarking that the Board had held a very large number of proxies, which, however, they had not thought it right to use.

The meeting then terminated with the customary votes of thanks, the proceedings having lasted over two hours. There will have to be a confirmatory meeting in about three weeks, and the scheme must then be approved by the Court.

WILLANS AND ROBINSON, LIMITED.

The fifth half-yearly meeting was held on Wednesday at the Cannon-street Hotel, Mr. Mark Robinson, M.I C.E. (chairman of the Company), presiding. Sir Gilbert A. Clayton East Bart., and Captain H. Riall Sankey, R.E (Ret.), M.I.C E. (directors) were also present.

The **Chairman**, in moving the adoption of the report and balance-sheet, which we published in our last issue, said he was again in a position to congratulate the shareholders in the name of the Board on the prosperous state of the Company's affairs, and doubly so when they considered the difficulties they had worked under at Thames Ditton. As they had not yet comfortably settled down at Rugby, they proposed only to pay a small dividend, but it was no inconsiderable thing to have carried over £10,000 to the reserve fund in two and a half years. They still adhered to the principle of writing off for depreciation of buildings, premises, and plant, and all those things which were wearable, £8,000 a year. With regard to the last issue of debenture stock they expressed the opinion that an issue of £75,000 would suffice, but it was strongly impressed on them by experts that a round sum of £100 000 would attract far more notice on the money market, and they felt that the growing expansion of the business warranted their doing it. Four and a half per cent. was the amount of interest estimated that they would have to pay, but they had succeeded in placing it at 4¼ without any difficulty With regard to the half-year's working, the comparatively small available balance of £10,000 was due in a large measure to the delay at Rugby in obtaining the structural steelwork which had hindered them and the contractors very considerably. The work in progress had increased from £24,000 to £33,000, and the work in stock from £23,000 to £34,000. More orders had come in than they could at present deal with, or that they were justified in dealing with, so they had limited them to the old customers and others which were considered expedient. They thought the new shops would be very convenient and commodious works, and they could confidently look forward to a very large increase in their revenue when they were in full working order. With regard to the half-yearly meetings, the directors thought it would be more advantageous to have one at Rugby every year—say, the autumn meeting at Rugby and the annual meeting in the spring in London.

The report was adopted after a few items in the balance-sheet had been questioned and explained, and the shareholders seemed to be in favour of holding one meeting at Rugby every year, but no decision was come to on this point, which will in all probability be brought forward at the next meeting.

A vote of thanks to the Chairman concluded the meeting.

ELMORE'S PATENT COPPER DEPOSITING COMPANY, LIMITED.

The report and statement of accounts of the directors of Elmore's Patent Copper Depositing Company Limited, to June 30 last states that the Board believe it to be in the interest of the Company to hold the annual meeting in London some time in October or November, when further experience of the increased output of the works will have been gained, and more definite information in regard to the copper supply scheme hereafter referred to, and other important matters, will be available. Notice of the meeting will be issued in due course. The manufacturing account yields a gross profit of £6,895, and after writing off the trading expenses and providing £500 for directors' fees, there remains a net profit from the industrial branch of the business of £4,176 available for meeting the charges (direct or indirect) entailed by the Haigh Park freehold estate. The balance of £1.522 is carried forward to next year. It should be specially observed that the revenue this year receives no benefit from the sheet license royalties which for the previous four years yielded £1 250 per annum to the credit of profit and loss. Previous years show the following balances: June 30, 1892 a loss of £8,566; June 30, 1893, a loss of £13,655; June 30, 1894, a loss of £10,435; June 30, 1895, a profit of £480, including £1,250 royalties; June 30, 1896, a profit of £1 521, exclusive of all royalties. This represents a further considerable improvement over previous years, especially in view of the fact that chiefly owing to the want of support given by the shareholders to the debenture issue in November last (the issue was subsequently withdrawn) the six months ending December 31 compare—according to an approximate balance sheet prepared by the secretary—very unfavourably with the following six months. Consequently the very satisfactory result for the year shown by the accounts arises principally from the use of £8,000 advanced by the directors at the end of 1895, and proves the statement made in the last report that the profits would rapidly augment if the company were properly furnished with capital. The manufactured stock has been valued on a very different basis from that hitherto adopted, which has been much too high. This year the approximate manufacturing cost only has been added to the cost of the raw material, without any additions for general charges. In the case of the stock of electrolytic copper, the price taken is considerably under the market price of the day, but in the case of the raw copper, which has been very well bought, the market price at June 30 has been adopted, in order that the shareholders may see the benefit of these purchases, and as the resulting profit is carried forward to next year it forms a reserve in the event of a drop in the market price. The works and plant have been maintained out of revenue in a state of thorough efficiency at a cost of £711. The output, orders, and deliveries are considerably in advance of those for the previous year, and 65 new customers are added to the books. The working expenses per ton continue to diminish with the larger amount turned out by the factory, but could be still further reduced by a larger output After an exhaustive series of comparative tests, the Board of Trade have sanctioned the use of Elmore copper tubes, of any diameter, in passenger steamers built under their survey. The Admiralty have instructed the Company to supply steam-pipes to the Portsmouth Dockyard, and the same are now under test. The Company accordingly expect to be appointed to the Admiralty list of contractors shortly. The unequalled quality of Elmore products continues to receive increasing recognition from all classes of users, both at home and abroad. A license has been granted for the manufacture of small tubes up to 4in. in diameter, subject to the payment of a satisfactory royalty per ton to this Company. Revenue from this source may be expected before the end of the current financial year. A contract to run for some years has been entered into, whereby the directors believe that the Company's raw copper supplies will be obtained on extremely favourable terms. In the past, having to pay cash for copper, and at the full market price of the day, and purchasing in small quantities, has very seriously curtailed profits. The Company has received notice from the Great Northern Railway Company of the compulsory purchase of a part of the freehold estate, and the price to be paid has been referred to arbitration. As soon as this question is settled the directors will energetically push forward the realisation of further lots. The Company in November last resolved to reduce its ordinary share capital from £182,390 to £91,195, by writing £1 off each £2 ordinary share. This step was confirmed by the High Court in April last, and the usual addition of the words "and reduced" to the title of the Company was dispensed with. The amount written off capital has been applied in the following manner: patents, £32,205; furniture, £131; buildings, etc., £2,060; stocks, £2,500; plant, £9,073; investments, £8,806; bad debts, £1 000; provision account, £1,000; profit and loss, £34,420 (£1,012 2s. in addition is written off plant and charged to the reserve account). Effect has been given to this special resolution to reduce the capital in the balance-sheet now issued New certificates will be issued to shareholders desiring to have them, but the exchange is not compulsory and is not invited. All certificates issued in future will of course be in accordance with the fact of the reduction of capital The directors earnestly ask the shareholders to thoroughly consider the Company's position. In the past very sanguine anticipations were prematurely expressed—£70,000 was distributed in dividends which should have been husbanded for trading purposes—and about £70,000 was sunk in freehold land, involving a very heavy annual charge for interest. The natural consequences were that the Company was denuded of working capital long before it could hope to overcome the initial difficulties common to every new enterprise, or to show the real merits and possibilities of the business. Only very small and most inadequate further sums of capital could be raised with the utmost difficulty and on exceedingly onerous terms; hence the business has never yet had a fair chance, although, thanks to the devotion of some of the Company's servants, a moderate success has been shown sufficient to convince every observer that the Elmore process produces an altogether unequalled finished article at a very low cost Having to deal with a very costly form of raw material at £40 to £50 a ton, as contrasted with an iron foundry where the raw material is perhaps only one-twentieth the cost of copper, a large capital is necessary for stocks in trade, and to allow the usual trade credit to customers; thus our competitors' accounts show their stocks to be many times the amount of ours, exclusive of very large cash and debtor balances. The shareholders cannot fail to see that without sufficient funds in hand the works cannot by any possibility produce large results, and all that the present directors—who share no responsibility for the mistakes made in the earlier years—could possibly hope to accomplish has been accomplished—namely, to show that a profit can be made even under the most unfavourable conditions, and thereby enable the shareholders to appreciate the real merits of the business and its potential success. The gross profit of £6,895 which has been earned this year, with very slender means, is not large if measured by ordinary standards, nevertheless the Board feel intensely pleased with the result, which amply vindicates the Elmore process, and think it will prove to the shareholders and others that the business now only requires capital on reasonable

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terms to secure the success which was originally anticipated. The accounts show conclusively that the business can earn even a high rate of interest on new capital, and still leave a surplus for the original capital. The Board, therefore, are formulating a scheme for properly financing the Company, and hope to lay the details before the shareholders at an early date. Accompanying the above is a report of the auditors and of the Board on the accounts for the year ending June 30, in which it is stated the Board regret that there should be any want of unanimity among the directors in presenting the accounts, but the majority are convinced of their correctness in principle and in form, as well as being in accordance with the books and vouchers relating thereto. The points at issue, together with the views of the auditors thereon, were recently laid before a large number of the shareholders who for themselves and their friends hold more than one-half of the shares, and they all, without exception, thoroughly support the conclusions of the Board, and even went so far as to sign a request to call in an independent auditor. The matters in question have been informally referred to representatives of four first-class firms of auditors, and to other accountants, and their opinions strongly justify the views of the Board, who prefer, however, that the shareholders should be the final judges in the matter. When the present Board was formed in July, 1894, Mr. J. W. Close, C.A., Leeds, was the Company's auditor, but shortly afterwards he was asked to withdraw in favour of the Chairman's nominees—Messrs. Blackburn—and their fee for work done that year was £150, and £52. 10s. in 1895, which the chairman justified as against the complaints of the shareholders at the last general meeting on the ground that he himself being unfamiliar with accountancy matters had had to frequently consult the auditors on the accounts, but he hoped that next year the fee would be less. Accordingly, this year the Company very carefully prepared the balance-sheet, and minimised the work of the audit to the utmost, so much so that the chief auditing clerk remarked that there was very little left for them to do. Twenty-five guineas are reserved for the auditors this year, which is considered ample, but they have sent in a bill for £52. 10s. They began on July 28, and might have finished in 10 days, but it was not until September 23 that the Board got their final report. In the interval the Board called for the auditors' certificate, as the shareholders were constantly urging the issue of the accounts. The Board state that they mention these things merely to show that unpleasantness has arisen in the past, which they think must largely account for the nature and tone of the auditors' report. The text of the auditors' remarks and the Board's comments thereon are given alongside.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Dresden.—Tenders for 3,710 wooden telegraph posts for the Saxon State Railways are receivable at Dresden on October 15.

Stettin.—Tenders for the supply of telegraph posts will be received by the Administration of the Prussian State Railways at Stettin on October 17.

Bucharest.—Tenders will be received at the Mairie, Bucharest, on November 16 for two stand-by steam-engines for a water-power electric generating station at Grozavesti.

Brussels.—Among the contracts for the supply of stores to the Belgian State Railways, tenders for which are receivable at the Brussels Bourse on October 21, is lot 110, consisting of various sizes of electric light carbons.

Madrid.—Tenders will be received on October 12 by the Direccion General de Correos y Telegrafos at Madrid for the supply to the Spanish Government of 60,000 telegraph insulators. The upset price is 1 peseta (9½d.), and a 10 per cent. security will be required.

London.—Tenders will be received on October 26 for the supply of red fir telegraph poles for the Postmaster-General. Also for creosoting the poles. Particulars and forms of tender are obtainable from Mr. C. E. Stuart, controller of stores, General Post Office, London, E.C.

Villefranche-Lauragais (France).—The Municipality of Villefranche-Lauragais (Haute-Garonne) have invited competitive plans for a public water supply and electric lighting. Prizes of 1,000fr., 500fr., and 200fr. are offered, under the usual conditions, and schemes must be sent to the Mairie by October 10.

Brussels.—Tenders will be received on October 21 for the supply to the Belgian telegraphic service of (1) a quantity of galvanised iron wire, (2) various lengths of cable for riverine, submarine, and land service, and (3) a quantity of bare and insulated copper wire. No details are advertised as to the amounts required, but particulars are obtainable at the Brussels Bourse.

Werl (Germany).—The Local Authorities propose to submit to tender the construction and maintenance of an electric power and lighting generating station, and also an electric tramway from Werl to Wikede, with an eventual extension to Hamm. Further particulars will be obtainable at the Rathhaus, Werl-i.-Westf., Germany. The date for the tenders is November 3.

Cologne.—Tenders are required by the Municipal Authorities for the construction and working of electric tramways in the city of Cologne to an aggregate length of 20·3 kilometres (12½ miles). Specifications, plans, and particulars are obtainable for 10 marks (10s.) from der Registrateur B, des Oberbürgermeisteramt, Köln, Germany, and tenders must be in by November 6.

Madras.—Tenders are invited for the lighting by electricity of Government House, Madras, including the banqueting-hall and aide-de-camps' bungalow, and also for the lighting of Government House, Guindy, including the military secretary's bungalow. For particulars application must be made to the consulting architect to the Government, Chepank, Madras. Tenders will be opened on November 11, 1896.

Brussels.—Tenders will be received on October 21, at the Bourse Brussels, for installing the electric light at the Arlon Railway Station, including the offices and works. Particulars are obtainable at the Brussels Bourse. La Société national des chemins de fer vicinaux will receive tenders up to October 28 for the conversion of about 14½ miles of tramway in the suburbs of Charleroi into electric lines on the overhead system. Particulars are obtainable, price 1fr., from the office of the Société, Brussels, rue de la Science 26.

Leeds.—The Council require tenders for the supply and erection of No. 2 overhead travelling cranes for the engine-house of the tramways electricity generating station, The Calls, Leeds. Tenders, endorsed "Tender No. 8 for Cranes," must be sent in, addressed to the Town Clerk, Town Hall, Leeds, not later than 12 noon on October 13. Particulars, plans, and forms of tender may be had from the City Engineer, Municipal Buildings, Leeds, or from Dr. John Hopkinson, F.R.S., 5, Victoria-street, Westminster, S.W.

Bradford.—The borough electrical engineer is prepared to receive tenders for the following meters—viz., 117 Aron meters, 86 Frager meters, 24 Edison meters, 21 Oulton and Edmondson meters. A list giving details and capacity of the above meters can be had on application to the Electricity Office, Town Hall, Bradford. Tenders are to be endorsed "Tender for Meters," and to be addressed to the Borough Electrical Engineer, Town Hall, Bradford. All meters are guaranteed to be in good condition and working order.

Madrid.—The Secretary of State for Foreign Affairs has received a despatch from H.M. Chargé d'Affaires at Madrid stating that a free public competition is announced in the *Gaceta de Madrid* of September 4 for the grant of the contract for the construction and establishment of three submarine cables to join the islands of Luzon, Panay, Negros y Cebu, in the Philippine Archipelago. Tenders must be lodged within 90 days of the publication of the conditions at the Spanish Ministry of the Colonies, accompanied by a deposit of 50,000 pesetas. The particulars received can be seen at the Commercial Department of the Foreign Office between the hours of 11 and 6.

London, W.—The Great Western Railway Company require tenders for the supply from December 1 next to November 30, 1897, of telegraph instruments, telegraph apparatus, copper wire, G.P. wire, etc., telegraph ironwork and tools, telegraph drysalteries, carbons for electric light, telegraph poles, etc. Samples and patterns may be seen at Swindon from 12th to 23rd inst. on application at the office of the Stores Superintendent at Swindon. Specifications, with forms of tender, may be obtained at the offices of the Stores Superintendent at Swindon. Tenders, addressed to Mr. G. K. Mills, secretary, Paddington Station, London, and marked outside "Tender for Stores," will be received on or before 26th inst.

Christiania.—The Secretary of State for Foreign Affairs has received a despatch from her Majesty's Consul-General at Christiania stating that tenders are invited for the delivery of 22,000 linear metres (13 miles 1,180 yards) of rails, with the accompanying fishplates and screws, for the electric tramline to be constructed between Christiania and Holmenkollen. Tenders are to be sent in sealed envelopes, marked "Aubud," by October 15, 1896, to the Tramline's Offices, 47, Kirkeveien, Christiania, where the conditions can be procured. The rails must be delivered in Christiania by January 1, 1897. Further particulars on the subject are expected from her Majesty's Consul-General, and will be on view as soon as they have arrived at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 6 p.m.

Morley.—The Electric Lighting Committee of the borough of Morley are prepared to receive tenders for the supply and erection of the following plant. (The whole bound up in one specification; price £2. 2s., returnable on receipt of a bona fide tender): Section A—Boiler-house plant: Lancashire boilers and fittings, feed pump, etc. Section B—Engine-house plant: steam alternators and exciters, motor alternator, accumulators, steam and exhaust pipes, valves, etc. Section C—switchboard and instruments. Section D—overhead crane. Section E—underground work: cables and stoneware culverts. Section F—transformers and switchboards. Section G—arc lamps, posts, and accessories. Section H—meters. Tenderers are at liberty to tender for any section, but not for part of a section. The ground plans of plant and specification, with terms and conditions of tenders and contract, may be obtained at the offices of Mr. Robert Hammond, the consulting engineer, Ormond House, Great Trinity-lane, London, E.C., on payment of £2. 2s. for each copy, which sum will be refunded on the return of the specification, filled up with a bona fide tender. Tenders, sealed and marked "Tender for Electric Lighting," must be addressed to the town clerk, Mr. R. Borrough Hopkins, at the Town Hall, Morley (Yorks), and be delivered on or before Wednesday, October 14.

RESULTS OF TENDERS.

Belfast.—The Corporation have accepted the tender of the Acme Gas-Engine Company for a new engine and dynamo for the electric light station.

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Down.—The Governors of the District Asylum have accepted the tender of Messrs. Wm. Coates and Son, Belfast, to fit the asylum with electric bells at a cost of £20.

Newcastle.—The Arniston Coal Company have contracted with Messrs. Ernest Scott and Mountain, Limited, electrical and general engineers, for the supply of an electric pumping plant of considerable size for their colliery.

Watford.—The Board of Guardians have accepted the offer of the National Telephone Company to fit up telephonic communication between the workhouse, Dr. King's house, and the relieving officer's house for £10. 10s.

Birmingham.—The Corporation have accepted the tender of Messrs. Mavor and Coulson, of Glasgow, at about £8,000 (the lowest tender received) for the supply and construction of electric lighting plant at the new meat market. Messrs. Lea and Thornbury were the consulting electrical engineers.

Cheltenham.—Tenders for 20 electric lamp pillars, as per design, for the Promenade were received as follow: Messrs. Hardy and Padmore, Worcester Foundry, fitted with plain wrought-iron tubes, £12. 17s. 6d. each, delivered at Cheltenham; Messrs. Andrew Handyside and Co., Limited, Britannia Ironworks, Derby, £18. 15s. each, with tubes, delivered at Cheltenham; McDowall, Steven, and Co., Limited, Milton Ironworks, Glasgow, £11. 15s. each, without tubes, delivered at Cheltenham. The Corporation have accepted the tender of Messrs. Hardy and Padmore.

BUSINESS NOTES.

Westminster.—The St. George's Vestry have resolved to light the stables by electricity.

Great Northern Telegraph Company.—The receipts for the month of September were £24,000.

Eccles.—The Town Council are about to experiment with incandescent electric lamps for street-lighting.

Crewe.—The new isolation hospital is to be lighted by electricity so as to increase the accommodation for patients.

Dover.—Arrangements are being made for lighting the pit which is being sunk by the Kent Coalfields Syndicate near Dover, with electric light.

Garthorpe.—It is expected that the extension of the telegraph from Crowle to Garthorpe will be completed the early part of the present month.

West India and Panama Telegraph Company.—For the two weeks ended September 30 the receipts were £1,639, as against £1,720 for the corresponding period of 1895.

Ramsbottom.—At the monthly meeting of the Urban District Council, a committee was appointed to take into consideration the advisability of lighting the town by electricity.

Wilmslow.—At the meeting of the District Council some discussion took place with reference to the electric light, and it was ultimately decided to apply for a provisional order.

Astrakhan.—According to the *Elektrotechnischer Anzeiger* the construction and working of the Astrakhan electric tramways are to be undertaken by a company domiciled in Belgium.

Oriental Telephone and Electric Company, Limited.—The directors have resolved to pay an interim dividend of 4d. per share, free of in ome tax at the end of the current month.

Woking Sanitary Electric Laundry Company, Limited.—This Company has just been floated, with a capital of £10,000, in £1 shares. The object is sufficiently indicated by the title. Registered without articles of association.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending October 4 amounted to £1,184, as compared with £1,088 in the corresponding week of the previous year, being an increase of £96.

Hampstead.—The street-lighting experiment referred to at a recent meeting of the Vestry by Mr. C. H. Reed, chairman of the Lighting Committee, is, we are informed, not with incandescent gas, but with incandescent electric light.

Bury.—At the meeting of the Town Council it was stated that the electric installation would be complete by the middle of the present month, and it was resolved that the principal centres of the town should be lighted by electricity.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ending October 2 were £2 203. 19s. 5d., compared with £1,942 19s. 10d. for the corresponding period of last year, being an increase of £260. 19s. 7d.

Gloucester.—The town clerk laid before the last City Council meeting a Queen's printer's copy of the Electric Lighting Order Confirmation (No. 1) Act, 1895, confirming (*inter alia*) the Gloucester Corporation Electric Supply Order, 1895.

Eastern and South African Telegraph Company.—The payment by warrants on November 2 is announced of interest on the 4 per cent. Mauritius subsidy debentures. The transfer books will be closed from October 27 to November 2 inclusive.

Stockton.—At a meeting of the Tees Conservancy, Mr. Hanson, chairman of the Graving Committee, stated that a visit had been paid to the Tyne to inspect the electric light installations at the graving docks there, and a report would be made and submitted.

Bristol.—The report of the Electrical Committee, recommending the acceptance of a contract for the extension of the central station, at a cost of £16,974, was adopted at the meeting of the Town Council. The committee had estimated the cost at £16,500.

Grantown (Elginshire).—The ratepayers are considering the advisability of lighting the town with electricity. They have had a scheme before them estimating the necessary outlay at £4,500.

Canadian Pacific Railway Strike.—The backbone of the Canadian Pacific Railway telegraphists' strike seems effectually broken, and the strikers are returning to their posts all along the line. The company's freight as well as passenger service is now working well.

Eastern Telegraph Company. — Payment by warrants on November 2 of interest for the half-year ending October 31 on the 4 per cent. mortgage debenture stock is announced. The transfer books will be closed from October 27 to November 2, both days inclusive.

Anglo-American Telegraph Company.—The directors have resolved to declare an interim dividend for the quarter ending September 30 of 12s. per cent. on the ordinary stock and of £1. 4s. per cent. on the preferred stock, less income tax, placing £6,000 to the credit of the renewal fund.

City and South London Railway.—The returns for the week ended October 4 were £903, compared with £887 for the corresponding period of last year, being an increase of £16. The total receipts for the half-year 1896 were £12,715, compared with £11,857 last year, being an increase of £858.

Lytham.—In the Streets and Beach Committee minutes read at the meeting of the District Council, a letter was incorporated from the solicitors of the Blackpool Tramways Company urging objections to the alterations in the agreement. A resolution was passed that the agreement be approved.

Wakefield.—At a meeting of the Tradesmen's Association a resolution was passed instructing the secretary to communicate with the Corporation in relation to the electric light, asking for information as to when the inhabitants may reasonably expect to be supplied therewith, and upon what terms.

Japan.—The Japanese telephone system is about to be greatly extended. In Tokio there are 2,000 subscribers, and more than 2,600 applicants are waiting. The Government wants to establish electric services of various kinds on a large scale, and a commission is now in the United States studying the subject.

Hastings.—The Town Council have given their assent to a notice from the secretary of the Hastings and St. Leonards-on-Sea Electric Light Company, Limited, of the intention of the company to extend their main in Church-road and De Cham-road, subject to the works being carried out to the satisfaction of the borough engineer.

Windermere.—At the meeting of the Council the clerk brought up the matter of agreement of the Council with the electric light company. The difficulty as to the price of the lamps, whether they should be 30s. or 38s., was still pending. It was left to the Highway Committee to settle, and power was given to sign the agreement.

Edison and Swan United Electric Light Company, Limited.—The following alterations have been made in the staff of this Company: Mr. C. M. Downie has resigned his office of sales superintendent and Mr. Edward Coote has been appointed general manager in his place. Mr. J. Cooper has been appointed as accountant in the place of Mr. Edward Coote.

Ramsey.—At a meeting of the Town Commissioners it was decided to invite two companies who are competing for powers to construct an electric railway from Laxey to Ramsey to lay their respective schemes before the Board, so that the Commissioners may judge which to support when the matter comes before the Tynwald Court on the 28th inst.

Swansea Copper.—Messrs. Richardson and Co.'s (Copper Ore Wharves, Swansea) quarterly circular has just been issued. It shows that the Swansea imports of copper produce for the quarter ending September 30 were: ore, 33,220 tons; regulus, 8,678 tons; copper, 612 tons; and precipitate, 5,394 tons. The exports in the same period were 1,159 tons 10cwt. 20lb.

Llanelly.—At a meeting of the Highway Committee of the Borough Council a letter was received from Mr. J. C. Howell, electrical engineer, offering to light up Station-road by electricity for a few nights at his own expense, in order to give a sample of how the work of electrically lighting the whole town would be done if entrusted to his care. After a short discussion, the offer was accepted.

Tunbridge Wells.—Arrangements have been made for a continuous supply of electric light starting from October 12. The total number of lamps will soon reach 10,000, and no less than 950 lamps were put on during September, the consumers now numbering 190. One of the new alternators is being used, and is already overloaded, so that the needed enlargement is being pushed on as quickly as possible.

Books Received.—We have to acknowledge from Macmillan and Co. the receipt of "The Elements of Electro-chemistry." This is a translation by Mr. W. R. Whitney of Prof. Max Le Blanc's work on the subject. We have also received from G Philip and Son "A Systematic Course of Geometrical Drawing," by Mr. T. A. Ford. We hope to give a further notice of these two books shortly.

Altrincham.—At the meeting of the District Council the minutes of a special meeting approving of an electric tramway were approved. At the same time the Council were strongly opposed to the overhead system, and covenanted that there should be an express understanding that the Council would be secured the option of purchase of that portion of the undertaking within the Altrincham section.

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Chichester.—A meeting has been held for the purpose of considering a communication from the National Telephone Company expressing willingness, should a sufficient number of subscribers be obtained, to extend their trunk line to Chichester, and thus bring the city into telephonic communication with the rest of the country. A small committee was appointed to consider the whole question and report at a subsequent meeting.

Phaeton Electrical Company.—We are informed that this Company will open on October 15 a branch office in London at 61 and 62, Watling-street, Queen Victoria street, E C, and as soon as the necessary steps can be taken the branch will be formed into a limited company. In the meantime Messrs. Krupka and Jacoby will act as managers of the branch, and as soon as the company is formed they will be appointed the managing directors.

Audenshaw.—The District Council have consented to the laying by the Manchester Carriage Company of a single line of tramway within the Council's district on Droylsden-road, with the necessary passing places, commencing from the boundary of the district at Williamson-lane to the junction of the company's line at Ashton Old-road, and have also assented to the company's application for a special Act or provisional order, *inter alia*, for the purposes named.

Dudley.—The Lighting Committee's report containing a recommendation that a provisional order be applied for to enable the Corporation to supply electricity for lighting and other purposes was adopted at the Town Council meeting. Alderman G. Bagott, in moving the adoption of the report, said he found that throughout England 96 similar applications had been made, and in about 70 cases provisional orders had been obtained.

Leeds.—The City Council have resolved to apply for powers in the ensuing session of Parliament for the extension of the tramways in various parts of the city, including Meadow-lane, Oldfield-lane, Aire street, Dewsbury-road, Hunslet Moor-road, Church-street, East-parade, Great George street, Park-lane, Cardigan-road, St. Michael's-road, East-street, and Upper Accommodation-road. The committee propose to take the trams into all the thickly-populated parts of the city.

Bombay.—We understand that the new "Lakhmi Vilas" Palace of H.H. the Gaekwar of Baroda, a description of which lately formed the subject of an exhaustive paper read before the Institute of Architects, is to be lighted throughout by electricity, and that the contract has been entrusted to a Bombay firm. The lighting of his Highness's Makarpura Palace has not long been completed, and the above will therefore be the second of his Highness's palaces to be fitted with the electric light.

Changes of Address.—Messrs. Ernest Scott and Mountain, Limited, of Newcastle-on-Tyne, have removed their London offices from 5, Crown-court, to larger offices at 20, New Bridge-street, Blackfriars, E C.—Dr John Attfield, F.R S., having resigned the professorship of practical chemistry to the Pharmaceutical Society of Great Britain, after a 34 years' tenure, has left 17, Bloomsbury-square, and continues his professional practice as a chemical consultant and analyst at 111, Temple-chambers, London, E.C.

Southport.—The electric lighting is being taken up very rapidly, and there is a probability before the winter is over that the demand will have overtaken the power of production. Since the exhibition, which was held in the Cambridge Hall a few weeks ago, 20 new customers have been added to the list, and of these five require 14 arc lamps. At the present time there are 170 consumers, representing about 12 000 8-c.p. lamps, in addition to the arc lights in the street, which amount to 1,200 more. The current is also being taken for motive power.

Appointment Vacant.—The Electric Lighting Committee invite applications for the post of electrician-in charge in the electric supply station, where there are two vacancies. Applicants must have held similar positions in high-tension alternating stations. Salary £2 per week. Applications, on foolscap paper, stating age, experience, and accompanied by copies of not more than three recent testimonials (which will not be returned), must be sent to Mr. F. C. Lloyd, town clerk, Town Hall, Huddersfield, by 10th inst., endorsed "Electrician-in-Charge"

Kensington.—The Vestry received 132 applications for the post of resident electrical engineer. The committee submitted the names of the following for final selection: Mr. J. G. Bell, of Manchester; Mr. H. W. Couzens, of Taunton; and Mr. J. Pilling, of Bolton. Mr. Bell was elected by a large majority. The Works Committee report that during the month of August 19 miles 1,690 yards of overhead wire and 200 yards of steel wire have been fixed; five new poles and one ground pole erected; 8 miles 320 yards of wire removed, and two poles removed.

Bray (Wicklow).—A letter was read at the meeting of the Commissioners from Messrs. Molloy and Molloy, solicitors, informing the Commissioners that the proposed pier and the electric tramway scheme were promoted by different gentlemen. Sir Henry Cochrane said it was understood that the same gentlemen were promoting the schemes. Messrs. Molloy and Molloy were acting as solicitors for both schemes. Mr. Cuthbert said he hoped they would not consent to have tramways run through the streets. The letter was marked "read," and the subject dropped.

The Trocadero Restaurant.—The electric light has been installed throughout this building. The new conduit system of wiring has been used, the whole of the cables and wires being drawn into specially-prepared wrought-iron tubes insulated inside and provided with inspection tubes as convenience dictates. The work has been carried out by Messrs. Strode and Co., and this is one of the largest buildings in London fitted with the system. The General Electric Company, Limited, call our attention to many other installations in hand, or recently finished, in which insulating tubes are being used.

Wallasey.—Mr. R. M'Geoch, in moving the adoption of the Gas and Water Committee's minutes at the District Council meeting, referred with satisfaction to an agreement effected with the Electric Free Wiring Syndicate, Limited, to supply all consumers of electric light within the district with initial charge. In the course of a discussion which ensued it was stated that the price to be charged for the light per Board of Trade unit would be 8d. Of this sum, ¾d. would be paid by the Council to the syndicate supplying the connections and fittings. The supply of light might be expected to commence about the end of the present month.

Brighton.—Notwithstanding the very heavy seas that accompanied last week's gale, we are informed that not the slightest damage was done to the permanent way of the sea-going car. On Thursday afternoon several trial trips were made, over 100 visitors being conveyed on each trip. The appearance and running of the car give the greatest satisfaction to everyone. With the exception of a small amount of concrete work, everything is now complete. The Town Council have adopted the report of the Works Committee recommending that permission be granted to the National Telephone Company to lay wires underground in various streets.

Light Railways.—The movement for the construction of light railways is making considerable progress in Germany. The number of existing and projected lines in Prussia is, according to the latest returns, no less than 167. Of these lines 103 were authorised by the Act of July, 1892, and 49 have not yet been constructed. Sixty of the lines are designed both for goods and passengers. The standard gauge exists on 39 lines, the 1 metre gauge on 39, the ·75 metre on 11, and ·60 metre on 7 of the systems. The lines worked by locomotives are 67 in number, 23 are worked by electricity, and 11 by horses, while 2 are worked partly by locomotive power and partly by horses.

Tonbridge.—Mr. F. Hastings Medhurst, consulting electrical engineer, has recently visited the town for the purpose of obtaining particulars for his report to the Council as to the best methods of lighting the town by electricity. He was accompanied by the clerk to the Council and the surveyor in visiting various parts of the town which it is thought could be profitably lighted by electricity, and in the end he expressed the hope that he should be able to present his report to the Council within a fortnight. We understand that a special meeting of the Council will be held on the 19th inst. for the purpose of deciding whether or not a provisional order shall be applied for in the ensuing session of Parliament.

Hanley.—The Town Council have decided on a report of the borough surveyor to extend the electric lighting in Newcastle-road as far as Mr. Twyford's works; also, owing to the increased demand for electricity, and there being every probability of the present capacity being fully taken up before September, 1897, to take advantage of the clause in the agreement with Messrs. Ferranti for the provision of a second engine, and that steps be taken to prepare a further application to the Local Government Board for borrowing powers. The ex-Mayor stated that the electric installation was paying its way, although the price had been reduced from 6d. to 5d. per unit. The salaries of the electrical engineers have been raised.

Another Metropolitan Electric Railway.—The Metropolitan District Railway Shareholders' Association write to the daily papers saying that a scheme has been approved by the directors for the construction of two deep-level tunnels for up and down service of express electric trains between Earl's Court and Mansion House, with an intermediate station at Charing Cross. The proposals for financing the scheme are as follows: the association will advance one million at 4 per cent. on the following terms—association to receive no interest until existing preference dividend paid in full. Association to provide all preliminary expenses. Association to receive a deferred bonus of one-half the profits after existing £2,250,000 ordinary stock has received a dividend of 5 per cent.

Portsmouth.—The Town Council have adopted the recommendation of the Electric Light Committee to let out on hire electric motors and electric ovens to consumers at 15 per cent. on the cost price. The Corporation have had some troubles to contend with in the shape of mishaps with the electric light, fuses blowing out, etc. The cause of the latter was due to the action of certain consumers who have made considerable extensions in the electric lighting of their premises without obtaining the sanction or even informing the Electric Lighting Committee. The demand for the current just now is extraordinary, and during the quarter just ended two and a half times more has been sold than in the corresponding quarter of last year. At a meeting of the Electric Lighting Sub-Committee, it was decided to recommend the full committee to provide three additional transformers to reduce the strain upon the present instruments.

Sunbury.—Wallace Williams, 13 years of age, was recently charged at Sunbury Police Court with breaking and entering a signal-box on the London and South-Western Railway, and stealing therefrom an electric semaphore and repeater, value £5. Mr. R. Sykes, solicitor, prosecuted. The prisoner was arrested on suspicion, and he admitted that he broke into the signal-box and stole the instrument. He said he effected an entrance to the box with a chisel, and cut the wires attached to the semaphore with a pair of pliers. A quantity of guttapercha wire, a battery, and other instruments were also found by the police, and prisoner admitted having stolen these also from the railway. Inspector Mason, of the National Society for the Prevention of Cruelty to Children, stated the boy was regarded as not being half right

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in his mind. The prisoner was remanded to the Kingston Workhouse for a week to see what could be done in his behalf.

Bolton.—At a meeting of the Gas and Electricity Committee the question of laying electric cables and supplying electricity to the Park Sawmills, Spa-road, was referred to the chairman and engineer. The engineer reported on the unsatisfactory working of the accumulators at the electricity works and correspondence on the subject with the makers. The matter was referred to the chairman and engineer for them to confer with the town clerk. A resolution was passed informing the General Purposes Parliamentary Sub-Committee that further statutory powers were required by the electricity department for the supply of electricity for tramways traction and for purposes outside the borough. The report was approved. The Town Council have decided to apply for powers to borrow £30,000 for electricity purposes.

Fulham.—With reference to the offer of the County of London and Brush Provincial Electric Lighting Company to submit a draft agreement and definite prices for the purpose of the Vestry transferring their provisional order to them, the Electric Lighting Committee recommended at the last Vestry meeting that, before receiving terms from any company, the clerk communicate with the metropolitan parishes and provincial towns who have taken up the electric light with a view to obtain information as to the terms upon which they have obtained provisional orders or have allowed them to be taken over by electric lighting companies. Having considered a letter from the County of London and Brush Provincial Electric Lighting Company, Limited, making formal application for the consent of the Vestry to their proposed provisional order, they recommended that the clerk be instructed to inform the company that the Vestry cannot consent to their proposed order, they having already decided to oppose their application.

Leatherhead.—At the Urban District Council meeting Mr. Dearle moved "That a memorial be presented by this Council to the Board of Trade applying for a provisional order under the Electric Lighting Act, 1882, to authorise this Council to supply electricity for any public or private purposes within the Leatherhead urban district." His reason for doing so, he said, was that they had been given to understand that a company which was being formed was about to apply for similar powers, and it was thought by some members of the Council advisable to secure such order themselves, thus preventing any company coming in. It did not follow, however, that they would be bound to act upon the order, and he wished it to be understood that he was not taking this course with any antagonistic feeling towards the present system of lighting. Mr. Howell thought it would be better for the matter to be referred to the General Purposes Committee, and he proposed, as an amendment, that this should be done. The amendment was eventually carried.

The City and Waterloo Electric Railway.—The construction of this railway is making steady progress, and the up line on the Waterloo side of the river is within a few feet of its terminus. Excavation is now going on under the approach to the Windsor line, and will soon reach the station, which has for some time past been in process of construction under the South-Western Company's station at Waterloo. The down line is not so far advanced. It has reached a point about 650ft. from the terminus, and there has come to a temporary stop. Between this point and Waterloo the South-Eastern Company have required the underpinning of the viaduct at Cross-street, and as this had to be done the engineers of the new line thought it expedient to sink a temporary shaft here and to work from this shaft backwards to meet the completed portion of the down line. On the City side the work is so far advanced that it is expected that in February the up line will be complete from Waterloo to the City station, which will be under the road between Queen-street and Bucklersbury.

Belfast.—At the meeting of the Corporation Councillor Andrews moved the adoption of the report of the Electric Committee, which stated that the committee had accepted the tender of the Acme Gas-Engine Company for a new engine and dynamo for the station. The committee had under consideration the advisability of putting down a much more extensive installation, and hope to report fully on the question at an early date. Councillor Andrews said it had been found necessary to add to the present gas-driven supply one Acme gas-engine, with dynamo, because they had seen that without taking any new customers they would in a week of heavy lighting have required their full potential output, unless they added to their plant. They had not yet got a vote in the Corporation for the steam-driven station, but a report would be brought forward when the Corporation considered the estimates of next year. In reply to Councillor Young, Councillor Andrews said the cost of the engine and the dynamo was £1,125. If they chose to remove the dynamos they could very well be driven by steam. The report was agreed to.

Exeter.—It was recommended by the Electric Light Committee at the meeting of the City Council that tenders be obtained for the instruments required for the equipment of the station, and that the surveyor be authorised to make arrangements with Messrs. Wheaton and Messrs. Hepworth for renting portions of their respective cellars for use as transformer stations. A letter was read from the surveyor to the General Post Office asking to be notified what special terms the Council were prepared to offer for the use of the electric light in Exeter Post Office, and the committee recommended that the terms offered be the same as those offered to the Devon and Exeter Hospital. The city surveyor reported that the remainder of the stores formerly belonging to the electric light company, of which the Council had purchased a portion, had been offered to him for a sum of £26. The committee recommended that the stores be purchased at the price named. They also recommended that the city surveyor be instructed to report upon the supply of power by electricity and the sums which should be charged therefor. The report was adopted.

Edinburgh.—Mr. Mathew Buchan, electrician, Portobello, has recently returned from the French Government arsenal at Cherbourg, where he had been sent by the Thomson Electric Welding Company, U.S.A., proprietors of the "Lemp" process of electric annealing of armour-plate, of which the surface has been hardened by the Harvey process. The apparatus having been installed under Mr. Buchan's supervision, a series of experiments were then carried out in presence of the French Government officials. It is stated that all the experiments were highly satisfactory, and demonstrated the value of the invention to modern naval construction. The *Edinburgh Evening Dispatch*, to which we are indebted for the above paragraph, also publishes a rough sketch of the annealing apparatus. The principle, of course, is the local heating of a portion of the surface of the plate by a heavy current applied by two copper contact pieces. The heating of course softens the surface of the plate, so that it will take the drill or other tool. The current used is an alternating one, and the secondary of the transformer which supplies the current to the contact-pieces has but one turn.

London.—At the meeting of St. James's Vestry a letter was read from Messrs. Moore and Burgess, of St. James's Hall, protesting against the dilatory manner in which the work in connection with the laying of electric mains was being carried out in the parish. Messrs. Moore and Burgess stated that in one week their receipts showed a diminution of £100, and that they expected that the coming week would show a larger decrease. The surveyor explained that the work had been delayed in consequence of the bad weather, and that there had been no unnecessary delay as far as the Vestry was concerned. He expected that by the end of October the whole parish would be lighted by electricity. The Electric Lighting Committee have reported that they had considered the question as to the desirability of obtaining guard-posts to the refuges now in the course of construction for the public arc lamps, and with a view of preventing any delay in the installation of the electric light in the public thoroughfares, an order had been given to Messrs. Freeman and Co., the firm agreeing to provide 100 guard-posts, according to pattern, at £3. 12s. each. Mr. Cheney complained that no other firm had been asked to tender, but no action was taken.

Catalogues.—Messrs. Ames, Garrard, and Co., workers in metal and engineers, of Goldney-place, London, W., have adopted a very sensible idea in their catalogue. They do not seek to utilise every available square inch of paper with minute diagrams and letterpress; on the contrary, the catalogue consists of a few pages containing a few illustrations, on one side of the paper only, of electroliers, brackets, and pendants, which are more in the nature of specimens (though a price-list is given at the end), for their aim is rather to design specially for each client wherever possible than to force upon his notice an endless array of stock patterns. The samples given in the catalogue are of very graceful and artistic design.—We have also received a copy of Catalogue B of the J. H. McEwen Manufacturing Company from the Stewart Electrical Syndicate, Limited, manufacturers' agents, 103, New Oxford street, W.C. It contains a dissertation on continuous current generators, pointing out the leading defects of the ordinary methods of design as they appear to Messrs. McEwen, and then goes on to describe how all these defects are claimed to be remedied in the Thompson-Ryan dynamo. The field magnets and the armature are fully described and illustrated, and the catalogue itself is a most creditable production.

Reading.—A letter was read at the Town Council meeting from the tramways company submitting an application for certain alterations and extensions of the tramways, together with the reconstruction of the present lines in order to the whole being worked by electricity. The letter also contained an invitation to the Council to visit Bristol to inspect one of the most recent installations of electric traction, which has now been in successful operation for nearly 12 months; and also offered to defray the expenses of the visit. The Mayor said they would agree that there were a few serious questions underlying the application, and it would be unwise to take action without carefully considering what it might lead to. He therefore moved that the matter be referred to a committee of the whole Council. The motion was carried. It was resolved to give notice to the Reading Electric Supply Company, in accordance with Clause 14 of the Reading Electric Supply Order, 1893, that the Corporation desire in future to exercise or discharge the powers and duties of the company in relation to the works of filling-in, reinstating, and making good all streets, bridges, sewers, drains, tunnels, or other works vested in or under the control or management of the Corporation which may be broken up by the company for the purposes of the above-mentioned order.

Nottingham.—There was a large attendance of interested visitors to Messrs. E. Reader and Son's Phœnix Works, Cremorne-street, Nottingham, the other day to see two sets of compound-condensing high speed engines for driving electric light at work. The engines, which indicate 150 h.p., and are capable of supplying no less than 1,600 lights each, have been built to order, and at the end of the week will be transhipped to the city of Charkow (Kharkof), in Russia. The invention, which is of a compact and at the same time of a most substantial character, and of the most approved type, is one likely to be very extensively requisitioned. It is capable of making 230 revolutions per minute, and will drive direct on to the dynamo. It is certainly a new departure in the engineering line for Nottingham; in fact, we believe that these

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are the first high-speed engines for electric lighting purposes which have been manufactured in the town. It is, therefore, satisfactory to learn that the prospects of a development of this branch are extremely favourable; indeed, Messrs. Reader and Sons are now about to put down two triple-expansion engines to indicate 600 h.p. and 150 revolutions, these also being destined for Russia. The firm in question are taking the branch up thoroughly, and, we are given to understand, intend to make this one of the largest departments of their business.

Cork.—At a special meeting of the Corporation the following minutes of the Electric Lighting Committee of September 18, called to consider and report on two tenders for transfer of the powers conferred on the Corporation by the electric lighting provisional order, were passed: "The report on the tenders by Messrs. Kincaid, Waller, and Manville showed that the prices quoted for current by the No. 2 tender (Cork Electrical Tramway Company) are more advantageous on the whole than that of No. 1 (London and Brush Company), even with the percentage of profits offered by the latter, that the first installation of plant, proposed by the tramways company, is more favourable than that of the Brush Company, while the capital to be expended in the first instance is one-third greater. That the proposal of the Brush Company as to acquisition of the undertaking by the Corporation is at variance with the conditions laid down, while the latter are tacitly accepted by the tramways company, that on the whole the latter company's proposal is far more advantageous for the Corporation than the other, and that the question of the Corporation exercising the powers under the provisional order was a matter for themselves to consider. Councillor Farrington proposed that the tender (No. 2) of the Cork Electrical Tramways Company be recommended for acceptance by the Council. Councillor Cronin seconded the motion." The motion was carried after certain modifications and additions had been made.

Pelsall.—At the Parish Council meeting, the Chairman said that in accordance with the wish of the Council a committee had met to consider the lighting question. The matter was carefully gone into, and it was estimated that to light the parish by means of electric light it would cost nearly £2,000, which meant a total cost to the parish of £250 per annum; but it was also estimated that there would be an income of £100 a year, so that for public lighting it would cost them £150 a year. They next considered the question of lighting by gas, and it was thought that this would be the cheapest means if they could meet the Rushall Parish Council as regards bringing the mains down Rushall-lane. To lay down the mains it would cost £400, and they would have to pay interest on this sum. The total cost would be about £88 10s. per annum. The next question was the lighting by oil, and it was estimated that this would cost something like £65 a year. Mr. Bickley asked if they had got any estimate of the cost of laying down of gas plant of their own. The Chairman said that they had not. Mr. Bickley said that if Brownhills could have a gas company he did not see why they should not. Mr. Binns said that the gas supplied by these small companies was of a very poor character. The Chairman said that these small companies could not supply gas at the price the Walsall Corporation could. The Corporation supplied gas at 2s. 7d. a thousand, whilst the Brownhills Company charged half as much again. Mr. Bickley said that that was all very well for private consumers, but it would not cost much more to the Parish Council if they had to pay interest on the outlay on the mains. The Chairman said he was of opinion that the place would not progress very much until they had some light. It was resolved that the committee be requested to obtain further information on the question.

Cheltenham.—A discussion took place at the Town Council meeting on the electric tramway question. Mr. Feeney, Alderman Drew, and the Deputy-Mayor expressed the fear that the tramway would practically be a railway, seeing that the gauge to be used was proposed to be 4ft. 8½in. in width—viz , the same as that of the Great Western and Midland Railway Companies, and that—so they now learnt for the first time—goods traffic was to pass over the line. The speakers feared the garden character of the town would be altered by allowing such traffic to be taken through its streets. Dr. Ward-Humphreys, Alderman Norman, Mr. Lawrence, and Mr. Parsonage pointed out these fears were groundless. It was reported that Mr. Lumley, on behalf of Mr. Nevins, the promoter of the tramway, raised an objection to a clause in the agreement prepared by the town clerk that the provisional order to be obtained should contain a proviso empowering the Corporation to purchase the undertaking at the end of a specified period. The town clerk replied that the Council considered that such a clause should be inserted, and this was agreed to. The electrical engineer reported that good progress continued to be made with the works and mains extensions—the Suffolk-square and Cambray extensions being complete, and a large part of the arc lighting mains laid; that the High-street extension was well in hand and that the remaining arc light mains were being laid; that he expected that the new steam alternator would be ready for work within a few days; that Mr. Herbert had applied for a service to the Imperial Rooms, and that this could been given from a low-pressure cable to be laid along the road behind the Promenade ornamental garden at a cost of about £50. It was decided to lay the service to the Imperial Rooms as suggested, and also to place an arc lamp in the open space near the Norwood Arms in continuation of the lighting in the Bath-road already ordered.

Blackburn.—The Town Council have resolved to apply to the Local Government Board for sanction to borrow £10,000 for laying down generating plant and equipping electric tramways in Blackburn. The Corporation will supply electric current to the tramways company at 3d. per unit on car mileage of 120,000 car miles, and 2d. per unit beyond that distance. Estimates show an annual profit of £800 to the Corporation, and a saving to the tramway company over the present methods of working of £1,400 per annum. The following minutes of the Gas Committee were adopted: "That the committee has considered the report of Mr. E. M. Lacy, A.M.I.C.E , on the application of the Blackburn Corporation Tramways Company, Limited, as to the terms upon which the Corporation would be willing to erect all necessary plant for working the Preston New-road and Witton sections of the tramway with electricity (the company having substituted the Witton system for the Cemetery section), and resolved: (1) That it be a recommendation to the Town Council to agree to the substitution of electric traction on the Preston New-road and Witton sections of the tramways, in lieu of animal power, and pursuant to the provisions of the Blackburn Improvement Act, 1882, to sanction electricity as a motive power on these tramways. (2) That the Corporation agree to provide the necessary generating plant and overhead wires and posts (the company providing the electric cars and motors), and to supply the company with current at the following prices—namely, on a car mileage of 120,000 miles, 3d. per unit; exceeding 120,000 miles, 3d. per unit on 120,000 miles, and 2d. per unit for every car mile above 120,000. The company to pay for a minimum car mileage of 100,000 at 3d. per unit. (3) That an annual fixed sum be charged to the tramways company for the maintenance of the overhead wires and of the electric motors and other electrical machinery used on the cars. (4) That it be a recommendation to the Town Council to apply to the Local Government Board for sanction to borrow the sum of £10,000 for generating plant, overhead wires, and posts. (5) That it be an instruction to the town clerk to prepare a formal agreement to be entered into between the company and the Corporation to carry out the arrangement, including all necessary details."

Birmingham.—The company promoted by Messrs. Mackenzie and Ross to take over the bulk of the Birmingham tramways has now been formed. The company has been registered with a capital of £1,000,000 in £5 shares. The number of directors is not to be less than five nor more than nine; the subscribers are to appoint the first; qualification, £1,000; remuneration, £1,250 per annum divided. The capital is divided into 80,000 5 per cent. preference shares of £5 each and 120,000 ordinary shares of £5 each. The present issue is 40 000 preference 5 per cent. shares of £5 each, fully paid; 60,000 ordinary shares of £5 each; and 3,000 mortgage debentures 4 per cent. of £100 each. This makes a total of £800 000 The preference shares are entitled to a cumulative preferential dividend of 5 per cent. per annum. They are also preferred as to capital. The mortgage debentures are repayable in 1917, and are limited to 500,000, being one-half of the capital. They will be secured by a trust deed constituting a first charge on the property of the entire undertaking. The trustees for the debenture-holders are Mr. J. A. Christie, Leamington, and Mr. James Ross, Canada. The board of directors has been constituted as follows: William Mackenzie, president of the Toronto Railway Company; James Ross, vice-president and managing director of the Montreal Street Railway Company; Henry Buckley, chairman of the Birmingham Electric Supply Company; and William Neale, chairman of the Birmingham Central Tramways Company. Mr. W. Holmden is the secretary, and Messrs. Millward and Co. solicitors. The company have acquired the Birmingham Central Tramways Company as a going concern for £485,000, and certain other payments. The existing tramways of the Birmingham Central Tramways Company consist approximately of 27 miles of single line, held upon several leases from the Corporation, terminating in 1907 and 1911 respectively, and of 14½ miles of single line outside the city boundary, held upon the usual conditions imposed by the Tramways Act of 1870. Terms have been approved by the city authorities for the surrender of the existing leases, and the grant of new leases for 21 years on a satisfactory basis as to the rental and for the substitution of an improved motive power. As to the future scheme nothing is yet settled, but the idea of the company is to link the existing lines, so that cars in connection may be taken from one end of the city to the other.

Telephones in Scotland.—Since the transference of the telephone trunk wires from the National Telephone Company to the Post Office many complants have been heard from manufacturers and other subscribers with regard to the inconvenience of the new system. One of the chief matters of complaint is that of the difficulty of getting connected, the fact that now four connections have to be made instead of two as formerly. causing great delay. Another grievance, which in many cases becomes an intolerable nuisance, is the "three-minute limit." In Arbroath the feeling of dissatisfaction with the new arrangements is so strong that most of the principal subscribers, rather than submit to the worry and inconvenience now being experienced in using the trunk lines, are threatening to have the instruments immediately cleared out of their establishments. The main objection to the new system is the rule which obtains, and which it is generally agreed is carried out by the operators with needless and exasperating officialism, that at the end of three minutes the connection ceases. There is a general complaint as to the length of time that is taken to effect the trunk line connections, and subscribers also find greater difficulty than formerly of hearing and making themselves heard over the trunk wires. Upon the whole the new system is looked upon with the utmost disfavour. At the meeting of the Fifeshire Standing Joint Committee Captain Bremner said that since the telephone system had been taken over by the Post Office authorities their service had simply been in a total state of disorganisation. In fact, and put shortly, he would

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not recommend the committee to continue the telephone system as at present. It was not worth the candle. The Chairman remarked that there was a general complaint all over the country regarding the way the telephone system was now worked, and it was simply intolerable. He recommended that a strong representation should be made to the Government authorities. Mr. Cathcart remarked that the report from Captain Bremner was that the telephone was practically useless, and he thought they should give it up altogether. Sir Ralph Anstruther coincided, and approved consideration of the offers for a telephone system. The Chairman, in reply to Mr. R. Glass, stated that the estimated cost was £1,600 or £1,700. Mr. David Lees said that in the arrangement with the Telephone Company the Council reserved the right to put wires on their poles, and he asked if that would be allowed now. The Chairman replied that the Post Office authorities had intimated that they would not allow the poles to be touched. The committee were instructed to consider the offers and report.

Dundee.—The members of the Harbour Trust have been discussing the best means of letting people know the correct time. One section favoured a time gun, and the other section advocated the control of the clocks by electricity. A time gun is already in existence, but the Harbour Trust at their last meeting decided by a big majority to discontinue their contribution of £50 towards it, so that probably the equivalent will be spent on electricity. At the Gas Committee meeting, Mr. Tittensor, the electrical engineer, formally submitted a recommendation that the present area of the system be extended so as to include a radius of between three and four square miles Under the existing state of things a radius of only about three-quarters of a square mile is scheduled. Mr. Tittensor was instructed to draw up a report showing the capital expenditure required for the proposed extension, the committee reserving their decision on the whole matter until that is done. Consideration was also given to the subject of the extension of the lighting of High-street and other thoroughfares by electricity. To effect an improvement in the present system of lighting, Mr. Tittensor recommended that the present lanterns be done away with and the canopy carrier adopted. This change would cost £8. 10s. per lamp, or £34 in all for the High-street lamps. As to the price charged for current, the present system of charging was at the rate of 5d per unit, which was the same as that charged to ordinary consumers. No charge, however, was made for carbons, trimming, or maintenance. Last year the four lamps burned altogether 3,709 5 hours, costing £154. 11s. 3d , or at the rate of £38. 12s. 9¾d. per lamp per annum, being 2½d. per lamp per hour. In Edinburgh the charge was £18 per lamp per annum. As, however, half the lamps were switched off about midnight, the actual cost per annum was £24 for lamps burning all night, and £18 for lamps burning only part of the time. He would recommend that the standards be each fitted with two bracket arms carrying two 50-c.p. lamps, and that at half-past eleven o'clock or thereabout in the evening the arc lamps should be turned off and these lamps turned on. On these lines High-street could be supplied at £25 per lamp per annum. He would also submit an extended scheme for the lighting of the principal streets in the town on the same lines as those which had been adopted in Edinburgh. He proposed to erect 56 extra lamp-posts with bracket hangers and lamps, and the necessary mains and pipes. The supply for these lamps would be taken direct from the mains supplying the town, and would not entail any alterations or additions to the present plant at the generating station. He further suggested that the energy be supplied at the rate of £20 per lamp per annum, including trimming, but exclusive of interest and sinking fund. The cost would be: 56 lamp posts, hangers, and lamps erected complete, £30 each—£1 680; laying and supplying pipes for the cables, £175; cables and switching gear, £330—total, £2,185. The interest and sinking fund would amount to £110, and the running cost—that is, supplying current, trimming, etc.—at £20 per lamp per annum, or 3d. per unit including trimming, £1,200. The committee approved generally of this report, but reserved consideration as to details.

Walsall.—Colonel A. G. Durnford, R.E., commissioner for the Local Government Board, has held an enquiry as to a proposal by the Town Council to borrow £2,500 for the purposes of electric lighting. The Town Clerk (Mr. J. R. Cooper) said that the population of the town according to the last census was 71,789 and the rateable value was £161,785. The outstanding loans were £168,011 for sanitary purposes. The present application was to borrow £2,500, repayable in 25 years, the same as the former loan. The former loan was £19,000, which was sanctioned in October, 1894, and of that £19,000 the Corporation had actually expended £18,690 according to the statement which he put in. At the time the former loan was sanctioned the Corporation contemplated erecting works, and the commissioner would see from the statement how the money had been expended. At that time two Lancashire boilers were put in, and they gave sufficient power for driving the engines in connection with the works, but the demand had really exceeded the expectations of the committee, and consequently further extensions were absolutely necessary. He might say that when the works were started, there were 42 customers and the output was 45 amperes at 2,000 volts. There were now 67 customers, and the output had increased from 45 to 60 amperes at 2,000 volts, showing an increase of 30 per cent. Then he was glad to say that the income had proportionately increased. The units sold in August were 42 per cent. higher than the units sold in July, while the units sold in July and August were together 95 per cent. more than for the months of May and June. The works which the Corporation had carried out comprised generating works and three transforming stations, and they commenced to run on December 21. One of the transforming stations was also a storage station. The current was generated at the generating station at 1,870 volts, and that was reduced at the transforming stations to 105 volts. At present the output at the transforming stations was 340 amperes each, while the three transformers would take 20 amperes each on the high-tension side. The three together would therefore take the whole 60 amperes from the generator at the present time, and the maximum loads reached the 60 amperes. Therefore, having regard to the increased demand which would be made during the winter, it had become absolutely necessary for the Corporation to put down another transformer and also another boiler so that in case of an accident there would always be sufficient power at the generating station. The present two boilers were required to meet the present demand, and they wanted a third in case of a breakdown. The matter had received the very careful attention of the committee and the Corporation, and they had come to the conclusion that to meet the demand likely to arise there was no alternative to this. The commissioner knew that electric lighting was one of those works which required very careful feeling and attention, and they had not overdone their expenditure at present, but to keep pace with the demands of their customers they were bound to do this work before the winter. He might say that so important did the committee feel this to be that they had already placed the order for the new boiler. The present boilers were of the Lancashire type, but as the Babcock and Wilcox type was a more rapid raiser of steam one of that type had been adopted. He then laid before the commissioner a detailed account of how the present £2,500 was to be expended, giving separate estimates for boilers, transformer, works, switchboards, etc. Mr. Wyllie (the electrical engineer), in reply to the commissioner, said that what was to be done was a repetition of what already had been done, no change of system or other alteration being contemplated. There were 14 public lamps belonging to the Corporation, but the greater part of the demand was from private consumers. The lamps supplied varied from 8 c.p. to 200 c p., but the great majority were of the ordinary 16 c.p.

Plymouth.—A Local Government Board enquiry has been held by Colonel Luard, R E., into an application by the Corporation for sanction to borrow £46,000 for electric lighting works. The Town Clerk said the Corporation in the year 1894 obtained an order under the Electric Lighting Acts. Inasmuch as it was then said in some quarters that electric lighting was in its experimental stages, the Municipality decided to proceed cautiously, and see whether, commercially or scientifically, that was so. A committee was appointed to deal with the matter, and to make enquiries of all local authorities as to what had been done. It was found that so far as local authorities had established electric lighting works, and had conducted them sufficiently long to enable a fair judgment to be made, they were a commercial success. Dr. Fleming, an expert, was then consulted, and his report was favourable to the introduction of electric light into the town. Some members of the Corporation having visited and inspected some of the chief electric lighting stations in the country, Mr. Rider, of Bolton, was appointed borough electrical engineer. He presented an exhaustive report (already printed in these columns) and the present application was based on that report. It was proposed to spend £46,000 on the works, and to have the generating station on the shores of the Cattewater, so that either water-borne or railway-borne coal might be obtained. The Board of Trade had already approved of the scheme, subject to certain proposals which they had to make. The population of the existing borough was 90,000, the ratable value to the general district rate £334,046, and the amount of the sanitary loans outstanding £309,016. The order, however, had been made applicable to the extended borough. Mr. J. H. Rider, the electrical engineer, put in his report, mentioning that the scheme provided for public and private lighting and traction power. The proposed power of the generating station was independent of the exact form of electric light which might be adopted; whatever system was adopted the power would be suitable. The committee had reported favourably on the overhead wire system. Mr. Debnam said from enquiries he had made the low-tension stations were those which were the most profitable, and he asked whether it was not possible to adopt that system. Referring to the traction power, the Corporation were proposing to charge the Tramway Committee 3½d. per unit for the electric power. He thought such a charge was unnecessarily heavy, and likely to hamper the efforts of the Tramway Committee to make that undertaking pay. In Portsmouth the Corporation had decided to sell to a private tramway company 1½d. per unit for electric power. The Inspector thought these points were outside his province. Mr. Rider, replying to Mr. Debnam, said with regard to the loss on the high-tension system as against the low-tension system, the provisional orders gave to corporations the power to supply the current over the whole of the borough in every case; but in no case had a low-pressure station been able to come up to its obligations to supply current over the whole of the borough. In every case the low-pressure station had its mains within a small area, never exceeding half a mile radius. That was the way in which the low-pressure system was made to pay. Plymouth Corporation, however, was bound to put down a system for the whole borough, and the high-tension system was the only one possible of adoption, unless low-pressure stations were established at various points. It was not in the total cost with the low-tension system so much as in the low working costs per unit that money was saved. Plymouth proposed to supply the current all day and all night, and in that way would be able to keep shifts

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of workmen continuously employed. Mr. Debnam wished it to be made clear that he was not opposed to electric lighting. Mr. J. Willoughby said, as chairman of the Electric Lighting Committee, and as one who visited Brighton and other places, he was convinced, not only of the advisability of the scheme proposed, but of the fact that Plymouth was benefiting greatly by the experience of other towns. There was no opposition to the application, and the Town Clerk asked for a period of 50 years for the land, 30 years for the buildings, and the longest possible period for the rest of the works.

PROVISIONAL PATENTS, 1896.

SEPTEMBER 28.

21449. **Improvements in apparatus for measuring and recording electric currents.** Hermann Aron, 6, Lord-street, Liverpool.

SEPTEMBER 29.

21487. **Improvements in or connected with coin-freed or actuated electricity meters.** George Ellis and George Hinde Nisbett, 15, Water-street, Liverpool.

21488. **Improvements in or connected with coin-freed or actuated electricity meters.** George Hinde Nisbett, 15, Water-street, Liverpool.

21509. **An improved electrolyser or electrolytic apparatus** John Gustaf Adolf Rhodin, 17, St. Ann's-square, Manchester.

21527. **Improved door or sash bolt for use in connection with electric circuits.** John Joseph Wilson, 73, St Stephen's-road, Upton Park, London.

21539. **Improvements in or relating to telephones.** Alfred Julius Boult, 111, Hatton-garden, London (George Milton Bair and Calvin Westley Ream, United States)

21559. **Improvements in dynamo-electric machines.** The British Thomson-Houston Company, Limited, 70 Chancery-lane, London. (Charles P. Steinmetz, United States) (Complete specification.)

21560 **Improvements in tandem-parallel controllers for induction motors.** The British Thomson-Houston Company, Limited, 70, Chancery lane, London. (William B Potter and Frank E. Case, United States.) (Complete specification.)

21561. **Improvements in the means of supplying current to electrically-propelled railroad vehicles.** Frederic Joseph Warden Stevens, 70, Chancery-lane, London.

21583. **Improvements in or relating to electrical signalling apparatus.** John Groves Hamerton, 111, Hatton-garden, London.

21591. **Improvements in or connected with electric circuits for telephonic communication** Franz Rumrich Joseph Juraske and Hermann Brockett, 40, Chancery-lane, London. (Complete specification.)

SEPTEMBER 30.

21617. **Improvements in electric heating devices.** William Edwin Heys, 70, Market street, Manchester. (D Chedville, France)

21632. **Improvements in electric light fittings.** Edward Wynne Donovan, Broughton Bridge Ironworks, St Simon-street, Salford (Complete specification.)

21668. **Centrifugal contact apparatus for effecting the connection of the armature windings of rotary phase electromotors on the attainment of a certain speed.** Siemens Bros. and Co, Limited, 28, Southampton-buildings Chancery-lane, London. (Siemens and Halske, Germany.)

21684. **Improvements in joints for electric light fittings.** John Webb Singer, Walter Herbert Singer, and Edgar Ratcliffe Singer, 40, Chancery lane, London.

21688. **Improved means of applying electricity to the human body.** William Phillips Thompson, 6, Lord-street, Liverpool. (Karl Zdrahal and Josef Minárik Austria)

OCTOBER 1.

21749. **Improvements in active material for secondary battery plates.** The Sussmann Electric Miners' Lamp Company, Limited, and Sigmund Adolf Rosenthal, 77, Chancery-lane, London.

OCTOBER 2.

21809. **Improvements in electrical burglar-alarms.** John Herbert Bower, Bank-buildings, George-street, Sheffield.

21822. **Improvements in leading in wires of electric glow lamps.** George Davis, 38, Margravine gardens, West Kensington, London.

21826. **Improved grids for plates in secondary electrical batteries.** Thomas Froggatt, 59, Warham-street, Kennington Park, London.

21879. **An electric furnace or oven** C. A Timme, 4, South-street, Finsbury, London.

OCTOBER 3.

21930. **An improvement or improvements in the method of ensuring a quick break in electrical switches known as the "knife switch," "chopper" switch, or "hatchet" switch.** George Herbert Verity, Plume Works, Aston, Birmingham. (Complete specification.)

21956. **Improvements in or connected with electric accumulators.** Jules Julien, 6, Lord-street, Liverpool.

21960 **Improvements in electric bells.** Josef Mohr, 97, Newgate-street, London. (Complete specification.)

21972. **Improvements in dynamo-electric generators and motors.** Sidney George Brown, 45, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1895.

18673 **Automatic speed regulator for electromotors.** Denayrouze.

18931. **Prepayment apparatus for attachment to gas, electricity, or other fluid meters.** Webber. (Date applied for under International Convention, April 16 1895.)

19245 **Dynamo-electric generators and motors.** Wood.

19734 **Means or apparatus for electrically igniting and governing petroleum and other like motors.** De Dion and Bouton.

19745. **Manufacture of plates for electric accumulators or secondary batteries.** Körner.

21283. **Electro-depositing of metals.** Elmore (Elmore.)

21830. **Electrical apparatus for firing fuzes for mines and other purposes.** Siemens Bros. and Co., Limited. (Siemens and Halske)

22586 **Single-phase alternate-current motors.** Siemens Bros. and Co., Limited. (Siemens and Halske.)

1896.

3712. **Electric accumulators.** Mouterde, Chavant, and George.

5274. **Apparatus for the electro-deposition of metals.** Smith, Smith, Smith, Smith, and Deakin.

12895. **Electric elevators.** Smith.

16168. **Electric insulators.** Smock.

16726. **Electrodes for secondary batteries.** Schneider.

17123. **Insulating joints for metal or armoured conduit-tubes, more especially suitable for electrical conductors.** Lake. (Greenfield).

17124 **Conduits, more especially suitable for electrical conductors.** Lake. (Greenfield.)

17180 **Combined typewriters and electro-telegraphic transmitters.** Wise (World Flash Company.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	8¾ 9
Brush Company, Ordinary	3	¾-1¼
—— Non. Cum., 6 per cent. Pref.	2	1¼-1⅜
—— 4½ per cent. Debenture Stock	100	110-113
Central London Railway, Ordinary	10	10½-10⅞
——	2	4⅜-4⅝
Charing Cross and Strand	5	9½-10
Chelsea Electricity Company	5	7½-8
—— 4½ per cent. Debentures	100	114-117
City of London, Ordinary	10	16-17
—— 6 per cent. Cumulative Pref.	10	17½-18½
—— 5 per cent. Debenture Stock	100	131-135
City and South London Railway, Consolidated Ordinary	100	48 50
—— 4 per cent. Debenture Stock	100	136-128
—— 5 per cent. Pref. Shares	10	14¾ 15¼
County of London and Brush Provincial Co., Ordinary	10	8¾-9¼
—— 6 per cent. Cum. Pref.	10	13¾ 14¼
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
Edison and Swan United Ordinary	3	1¾-2¼
—— 4½ per cent. Debentures	100	103-106
Electric Construction, Limited	2	1½-1¾
—— 7 per cent. Cumulative Pref.	2	2½-3
Elmore's Copper Depositing	2	¼-⅜
Elmore's Wire Company	2	¼-½
W. T. Henley's Telegraph Works, Ordinary	10	18-19
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	3¾-4¼
—— 7 per cent. Preference	5	8¾ 9¼
India Rubber and Gutta Percha Works	10	22-23
—— 4½ per cent. Debentures	100	105-108 xd
Kensington and Knightsbridge Ordinary	5	9½-10
—— 6 per cent. Pref.	5	8½ 8¾
Liverpool Electric Supply, Ordinary	5	8-8½
Liverpool Overhead Railway	10	13¾-13¼
—— 5 per cent. Pref.	10	17½-17⅞
—— 4 per cent. Mortgage Debentures of £100	100	112½-114½
London Electric Supply	5	¾-1¼
Metropolitan Electric Supply	10	12½-13½
—— 4½ per cent. First Mortgage Debenture Stock	100	120-123
National Telephone, Ordinary	5	7⅜-7⅝
—— 6 per cent. Cum. First Pref.	10	17-19
—— 6 per cent. Cum. Second Pref.	10	17-19
—— 5 per cent. Non. Cum. Third Pref.	5	6⅞-7⅛
—— 3½ per cent. Deb. Stock	100	106-109
Notting Hill Company	10	11½-12½
Oriental, Limited, £1 shares	1	1¾-2
—— £5 Shares	5	8½-8¾
—— £4½ shares	4½	7½-7¾
Oriental Telephone and Electric Company	1	¾-⅞
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	103-105 x 1
Southampton Electric Company	5	4¾-5¼
St. James's and Pall Mall, Ordinary	5	11½-12½
—— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	40-43
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	—	8-8½
Westminster Electric Supply, Ordinary	5	10½-11½
Yorkshire House-to-House		7½-8

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NOTES.

French Transatlantic Cable.—Three steamers belonging to the French Cable Company are now at Halifax preparing to lay the cable between France and the French colonies in America.

New Spanish Cables.—The *Gaceta* of Spain recently published a Royal decree announcing the intention to construct and establish three submarine cables to unite the islands of Luzón, Panay, and Negros y Cebú, in the Philippine Archipelago.

North-East Coast Institution of Engineers and Shipbuilders.—The second general meeting of the session of this association will be held in the lecture-hall of the Subscription Literary Society, Fawcett-street, Sunderland, on Wednesday, November 11, at 7.40 p.m.

The Pacific Cable.—It is understood that Mr. Laurier, the responsible head of the Canadian Government, intends to pay a visit to this country, in the course of which business questions attaching to the construction of the Pacific cable and the fast Atlantic service can no doubt be profitably discussed. The prorogation of the Dominion Parliament sets him free, and it is probable that the date of his arrival here will not be long postponed.

Leeds Mechanics' Institute.—"The New Photography" was the subject of an interesting lecture delivered on Wednesday evening before the members of the Leeds Mechanics' Institution and Literary Society in the Albert Hall. The lecturer was Mr. Richard Kerr, who explained the nature of the discoveries of Röntgen and Prof. Crookes, and showed electric sparks passing through various substances. He took a radiograph of the hand of the chairman, Mr. Arnott, which was passed round amongst the audience.

The Value of Electrical Engineers.—A farewell dinner party was given a short time ago in honour of a gentleman who was leaving London to take up a rather good position in France, and one of the guests in delivering a congratulatory oration remarked that it had been said on good authority that a labourer was worthy of his hire. The difficulty which faced electrical engineers as a rule was to find a hire worthy of the labourer, and they could congratulate their friend on having so successfully solved the question.

Newspaper Enterprise.—The *Glasgow Herald* have engaged a special correspondent in America to describe the chief systems of mechanical traction in use in that country, which will be read with more than ordinary interest by the citizens of Glasgow in view of the vexed state of the tramway question in that city at the present time. These articles may have a good deal of influence on the new Council, but if no steps are taken very soon, the whole matter may be postponed indefinitely. The first of these special articles appeared on October 10, and they are running daily.

The Corrosion of Aluminium.—The *Journal* of the Chemical Society summarises the results of the experiments of Mr. E. Donath on this subject. He found that hard aluminium foil is not attacked by boiled water, which is free from air, whereas ordinary water acts on it appreciably. Calcium sulphate in solution has no action on the foil, but solutions of chlorides, and especially of nitrates, dissolve it readily. Again, the author found that fats, fatty acids, and fused anhydrous phenol are all without action, but that a 10 per cent. boiling solution of phenol forms yellow spots, and caused part of the aluminium to enter the solution. He attributes this, however, more to the action of the air than to that of the phenol.

Illuminated Storm Waves.—The recent storms all round the south coast have caused considerable damage to sea-fronts. The waves dashing against the sea-walls and promenades are, however, always an attraction to visitors. The arc lamps now generally used to light the promenades add much to the beauty of these displays of wasted energy at night time. The illuminated effect as the waves roll and then break over the arc lamps can be compared favourably with many illuminated fountain displays. They are not so safe to watch, but the danger of a ducking give additional attraction to the scene.

The Telegraph in North Borneo.—Reuter's agent at Sandakan (North Borneo), writing under date of August 14, says: "I have just returned from the Labuk River, where all trade is at a standstill owing to Mat Saleh and his followers being in the district. The telegraph line across this country, which was put up from both ends, has now been joined, but owing to a breakdown somewhere near Sandakan no message has been sent through as yet. High winds have prevailed here for some time past, and as the track through which the line runs is not a wide one, falling trees are doubtless the cause of the break."

War to the Housebreakers.—M. Defert, secretary of the Commissariat of Police of the Saint-Avaye Quarter in Paris, has carried out an interesting experiment in the Fouillard Brewery, rue Montmartre. The system, of which M. Seguy, professor of physics at the School of Pharmacy, has given a demonstration, consists of an electric apparatus placed in the door-porter's room and a special lock fitted with a transmission plate, the whole connected with electric wires. If an instrument other than the special key is introduced into the lock, bells are put in motion and continue ringing. The porter thus has time to catch the invader before he has been able to proceed very far. The French paper, *L'Electricien*, adds a strong touch of dramatic realism to its description of the utility of this invention when it adds: "If this system had been applied to the War Office, the treacherous Dreyfus would not have been able to steal the documents in the desks of his colleagues after they had departed."

Small Portable Lamps.—The portable lamp supplied from a primary battery is a standard invention which may be relied on to appear at regular intervals. So we find that an enterprising firm at Calcutta are introducing "a novel and highly useful form of electric lamp which will be found to meet many requirements of residents in India, more especially those whose duties entail camp life or the living in roughly-got-up bungalows, or as engineers, surveyors, planters, etc. They will also be found of much use where a light is wanted for a short space of time, say 10 minutes or so, as in bed or bath rooms, store-rooms, verandahs, or in photographic dark-rooms, and similar situations." Unfortunately, this useful battery and lamp, which is also cheap and likely to last two to three years, have the qualification of giving light for a short space of time, "say 10 minutes or so." We do not know why engineers and surveyors in India should be satisfied with such short intervals of brilliant illumination, but similar novel and highly useful inventions in this country have failed from this cause.

The New Amazon Cable.—It is refreshing to come across a paper which is able to clothe its ideas in idyllic words, but it seems rather a pity that the transcendent genius which evolved the following poetic prose should be lost in the wilds of Brazil. What a vast scope there would be on the English technical journals! The paper in question remarks with regard to the inauguration of the new Amazon

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cable, that "upon the realisation of this legitimately patriotic event the Amazon, as if wounded by the shock of great commotions, felt the red blood freezing in its arteries. Now its heart is palpitating ardently, and its broad, bronzed breast is absorbing with the air the light which is poured down in a golden profusion of auroras and sunbeams. And while the Giant, the haughty Lion of the North, slumbered on his couch in divine ecstasy, the universal god, the wise god Progress, poured into his breast a vein of light like unto a running rivulet, limpid and brilliant. And this mighty vein, filled with a liquid compounded of globules of sunrays, is called—Telegrapho!" Further remarks by the same author on the electric light and electric tramways will be received with interest.

Telephones in Japan.—According to the *Japan Weekly Mail*, the Japanese Government, with the consent of the Diet, is to appropriate a very large sum during the next seven years for the expansion of the telephone service. The work of construction is being now actively carried on at various important places, the present intention being to complete, by March, 1898, the contemplated expansion of the service in so far as concerns Tokyo, Osaka, Yokohama, and Kobe, as well as the new constructive work in Nagoya, Nagasaki, Shimonoseki, and so forth, and to establish connection between Tokyo and Kobe. According to estimates for the current fiscal year, the number of new subscribers in the four cities of Tokyo, Yokohama, Osaka, and Kobe, under the expanded system, will be 13,333, and of those in Kyoto and 35 other places where the service is to be newly established, there will be 6,800. Side by side with the erection of telephones in so many places, the authorities will also effect various junctions between places already furnished with telephones. For instance, a connection between Tokyo and Kobe will be established *viâ* Osaka, Kyoto, Yokkaichi, Kuwana, and Nagoya.

An Electrical Boat.—A submarine torpedo boat is now in process of construction in the yard of the Columbia Ironworks, at Baltimore. According to a contemporary, it is calculated that this boat will be able to maintain a speed of eight or nine knots per hour when submerged to a depth of 60ft. The motive power will consist of a boiler heated by petroleum, supplying steam to three triple-expansion engines capable of developing 1,800 h.p. A battery of accumulators and an electric generating plant will also form part of this boat's equipment. The operation of this vessel is briefly as follows: When it is desired to go under water the smoke-stack is housed and the top covered over. The engines will be kept at full speed, and by turning some rudders the craft may be submerged to any desired depth. The speed is afterwards to be maintained by the dynamos running as motors and supplied by the accumulators which were previously charged. It is calculated that the battery plant will enable the boat to maintain a speed of 12 knots per hour for short distances. Air for the crew will be stored in reservoirs, and the supply may be replenished by a pump connected to a rubber tube terminating in a float on the surface of the water.

Chinese Telegraphic Signals.—We gather from the *Electrical Review* of New York that the telegraphic system in China is much hampered by the difficulties of the Chinese language. The characters used by this venerable nation are not so few as might be desired. The dot-and-dash system answers perfectly with our alphabet of 26 letters, but does not rise to the occasion when some thousands of characters are required. In consequence, a code has been adopted for all messages. But as only about one-eighth of the words in the language appear in this code, the exact expression of a message cannot always be given. This, and the double conversion before the message can be despatched and delivered, hinders the advance of the telegraphic system, and we understand that it is also difficult to obtain men sufficiently educated to handle the messages. The net result is that, although the principal cities in China are interconnected, the revenue does not provide for the necessary expenditure. The rush for news and the use of the telegraph as an aid to business transactions has not yet developed in the land. It is strange that the original discovery of the use of a magnet in China should be followed by such a lack of appreciation of the telegraph.

Indian Import Duties on Dynamos.—The following extract from a recent Customs circular of the Government of India deals with the import duty on dynamos and accumulators. It would seem that some enterprising business man hoped to pass both dynamos and accumulators off as prime movers. The following reply shows that the attempt was not successful: "I am directed to acknowledge the receipt of your letter referring to the question of the liability to import duty of dynamos and accumulators, and I am to say that, as observed by the Board of Revenue, the decision of the matter turns upon the question whether a dynamo can be classed as a prime mover within the meaning of No. 14 of Schedule IV. of the Indian Tariff Act. A dynamo is a machine for the generation of electricity, which is ordinarily set in motion by the application to it of a steam-engine, or other prime mover; and it is therefore not a prime mover itself. An accumulator is still more remote than the dynamo from the source of motion, and therefore is also excluded from the definition of prime mover. I am accordingly to state that dynamos and accumulators do not come within the exemption accorded to prime movers; and are chargeable with duty unless they form part of machinery intended for the special purposes mentioned under Article 14."

The Temperature of the Sun.—We gather from *Cosmos* the following interesting experiment by Prof. Ceraski, carried out at the Moscow Observatory. He had the use of a large mirror constructed by Messrs. Gettliffe and Simon, of Paris. This mirror was remarkable for the accuracy of its construction. It was silvered at the back, and had a focal length of about 39in. The thickness of the glass was varied to correct for spherical aberration, and a high degree of concentration could be obtained with it. The professor tried the old method of measuring the temperature at the focus when the mirror was exposed to direct sunlight, and found it to be about 3,500deg. C. This experiment only proves that the temperature of the sun is higher than this. The experimenter then tried a similar experiment using an arc lamp in the place of the sun, and with conditions as alike as possible. The intensity of the luminous source was then known to be very nearly 3,500deg., but the temperature at the focus was found to be only 100deg. to 105deg. C. The professor proceeds to argue that as the temperature of the source in this case was incomparably greater than that at the focus, so the temperature of the sun must be very much higher than 3,500deg. C. He also thinks that similar experiments may enable a true estimate of the temperature of the sun to be obtained.

Street-Car Litigation.—The *Western Electrician* comments on two recent cases of importance, in which the rights and responsibilities of street railway companies have been involved. The decision of Justice Patterson that a passenger standing on the platform of a street car did not forfeit his right to damages in case of an accident created considerable commotion in street railway circles, although it has not as yet resulted in an order to conductors to keep the car platforms clear. The Supreme Court has also given

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the following opinion as to the right of way in the case of cars and vehicles along the line of the street railway: "It is true that railway trains have the right of way, and if travellers in the highway know that the trains are approaching it is their duty to keep off the track. No such rule is applicable to the street railways and teams travelling in the streets of a city. The teams have a right to cross the tracks although cars are known to be approaching, otherwise teams would rarely be able to cross the tracks of street railways. Especially would this be true in Broadway, where cars are at all times in view and known to be approaching the point where teams are to cross." The Court adds that care is to be exercised by both motormen and drivers to avoid collision, and that whether there is negligence on the part of either is a question to be determined by the jury on the facts of each case.

Short Competitive Papers.—The secretary of the Gloucestershire Engineering Society, in his annual report, which was read at the meeting last week, says: "The council have spent a large amount of time and exercised very careful consideration in the preparing and arranging of a syllabus for short papers to be furnished in competition for prizes, and notices have been sent to the members inviting their co-operation in the matter; but I have with great regret and disappointment to state that no member has made any response to the invitation. This a matter which seriously affects the interests of the society, and in view of the fact that such a large number of artisans and mechanics (over 100) are members such a response might very reasonably have been expected. I sincerely hope that in the coming session each of the members will be able to furnish a paper, to last from five to ten minutes, and by such means greatly enlarge the interest of the meetings." The society includes within its scope of operations practically every branch of engineering, electrical and otherwise, even down to horseless carriages; and after this intimation by the secretary there ought to be no difficulty in securing a good supply of these competitive papers, which in themselves would be of great utility, besides enhancing the interest of the meetings.

Aluminium in Shipbuilding.—Colonel Henry F. Swan, in his presidential address at the meeting of the North-East Coast Institution of Engineers and Shipbuilders at Newcastle, said: "The great craving for excessive speeds, involving the lightest possible structures, especially in torpedo-boats, has led to the use of aluminium in some cases, but although this metal possesses many important qualities, and has been used with a certain amount of success, it cannot so far be reckoned as an important factor for general shipbuilding purposes. Concurrently with the great increase in the tonnage of individual vessels, and the size and weight of plates, beams, and angles, used in their construction, so has it become imperative to devise and adopt enlarged and improved appliances for handling them; it has therefore been necessary, not only to discard the machines of former days and replace them by others of a much heavier type, but also to provide mechanical means for lifting, and this is being done largely by cranes, worked both by steam and hydraulic power, as well as by electricity. An important example of the latter application may be seen in the yard of Messrs. C. S. Swan and Hunter, who have constructed large building sheds, carrying overhead electric cranes, thereby greatly facilitating the handling of the component parts of a vessel and depositing them in their required place in her structure."

Institution of Mining Engineers.—At the annual meeting of the South Staffordshire and East Worcestershire Institute of Mining Engineers, the president (Mr. R. S. Williamson) in his presidential address said that the day was not far distant when the use of naked lights underground would be prohibited by law, and electricity would no doubt form an important factor in lighting. Then all safety lamps should indicate the presence of firedamp and stythe. No doubt explosives were too largely used, more particularly in seams where a large percentage of round coal was not a necessity. He considered that the use of explosives should be subject to the most stringent rules, and, if gas was known to exist, should not under any pretence be used. The standing charges connected with coalmines were so great that any improvement calculated to reduce the cost of working was eagerly looked for. In his opinion, if mining associations and institutions would give good and substantial prizes for labour-saving appliances for use in mines, improvements would be made and the cost of working reduced. He was convinced that if they were to hold their own with their Continental competitors they would be compelled to give the question more attention. Foreign competition was viewed with contempt by some people, but unless they kept up to the times as far as economical working was concerned the competition would succeed sooner or later.

Electricity v. Gas.—In few, if any, towns in England has the fight between these two rivals been more keen than at Hastings. The gas interests have been actively upheld by the able engineer of the gas company, who does not hesitate to put his name to the statement that gas at 3s. per thousand can only be equalled for cost of light by electricity at 3d. per unit. Since the new system with alternate-current machinery has been introduced the electric light has persistently gained favour, in spite of the above prophecy. We have just received the latest pamphlet on the electric light side, and find that the resident electrical engineer is well able to keep up the fight. The pamphlet contains an excellent testimonial from a supplier using 150 lamps to replace 150 gas lights. He states "that the cost of lighting his premises during the first six months of 1896 with the new illuminant has been less than with the gas only in 1895 over the same period, and this in spite of having to pay for meters for both means of lighting this year, which represents an addition of 7s. 6d. to the cost. This is such a satisfactory result, and so different to what he was advised on all hands would be the case, that he felt bound to inform the engineer of it, as a testimony to the value of his own advice as to the distribution and placing of the lights throughout the buildings, and as to the candle power of the lamps to be used." This plain statement of fact will need some explanation when the gas engineer sends out his counter-blast.

Metallic Bobbins for Field Coils.—The *Electrical World* in a recent number summarises very clearly the advantages and disadvantages of the use of metallic bobbins for field coils. Apart from the better mechanical support which a metallic field bobbin affords the coil wound upon it, there is an important electrical advantage which may to a certain extent be obtained, but one which, however, is partially offset by a magnetic disadvantage. The metallic bobbin forms a closed secondary, which, in case the field circuit is broken, prevents an abnormal rise of voltage and a tendency to impair the insulation of the winding. This secondary action, however, makes that of the field magnet slower, and prevents it from responding to frequent and excessive changes in load, a condition which is very desirable but incompatible with the former. Quickness of action is sought by laminating the pole-pieces, while a slow action is to some extent restored by surrounding them with iron sheaths. Laminated pole-pieces are of unquestioned value in this respect, and the alacrity with which they allow of rapid fluctuations in the magnetic induction should not

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be counteracted too strongly by the use of heavy metallic spools. The electrical conductivity of the latter therefore becomes a matter worthy of serious consideration. It should be large enough to allow of only comparatively small currents to flow resulting from sudden and excessive changes of magnetism, which will be sufficient to protect the winding at such times. The latest type of field bobbin in America is made of riveted sheet iron, and the heads are of cast brass provided with many perforations. While thus obtaining economy in material and ease of construction, it is probable that some designers have so increased the electrical resistance of their field bobbins as to secure an important advantage of which they were not aware. The sheet-iron bobbins with wooden checks, so largely used by English designers, have practically the same advantage. Where laminated pole-pieces are not used, of course these considerations do not enter.

A National Physical Laboratory.—The committee which was appointed a few years back by the British Association to consider the question of the establishment of a national physical laboratory have reported strongly in favour of the suggestion. The committee was a very able and representative one, and in their report they remark that if England is to keep pace with other countries in scientific progress, it is essential that such an institution should be provided, and this can scarcely be maintained continuously on an adequate scale except as a national laboratory supported mainly by Government. Its functions should be the observations of natural phenomena, the testing and verification of instruments for physical investigation, and the preservation of standards of reference (an extension of certain branches of work now performed by the Kew Observatory), and the systematic accurate determination of physical constants and of numerical data which may be useful either for scientific or industrial purposes. The committee suggest to those whose business it may be hereafter to approach the Government that some such sum as £20,000 or £25,000 would serve to erect a building sufficient for all immediate necessities, and that posterity may be left to increase it as need arises. A sum of £5,000 would provide a fair amount of initial instrumental equipment of a permanent kind, and the rest should be met out of an annual grant. They propose that the head of this national laboratory should receive £1,200 a year, and they estimate that the additional assistance required would raise the sum expended on salaries to a total of £2,500 a year. The maintenance expenses and the apparatus fund would be adequately covered by another equal sum, much of which could be derived from fees, so that they estimate altogether that a supplementary annual grant of £3,000 per annum, and an initial expenditure of £30,000 for buildings and equipment, would do all that is essential to carry out the scheme in a wise and worthy manner.

Telephonic Disturbances. — The International Tramway Union recently addressed a number of questions to the various engineers in charge of electric tramways to ascertain, if possible, the best means of preventing the traction current from disturbing telegraphic and telephonic circuits. At the recent meeting of this society Mr. Paul Van Vloten, of Brussels, made a report on this subject. He classes the possible disturbances under three heads—*i.e.*, those due to actual contacts between the circuits; those due to leakage current; and, lastly, those due to induction effects. He also considered that the preventives of the effects could be subdivided as to whether they tend to prevent the disturbance in the tramway conductors, or to prevent these disturbances from upsetting the telegraphs. As to the currents in the tramway conductors, their voltage and intensity cannot be changed, but means may be adopted to diminish fluctuation. Still, as the author points out in his report, the fluctuations due to stopping and starting of the cars are comparatively slow ones, and do not have much effect on the telephones. The more rapid oscillations always found in the power circuits are due to the commutator of the dynamo. The passage of successive commutator strips under the brushes and the momentary short-circuiting of a certain coil produced a regular and rapid fluctuation in the current supplied. This cause is most important, and the notes due to these vibrations can generally be identified. Another cause is the continual variation in the resistance of the circuit due to the contact resistance between the wheels and the rails and between the trolley and the trolley wire varying. The author then proceeds to review the replies sent in to the society on this matter, and concludes as follows: To reduce the telephonic disturbances it is advisable to employ commutators having a large number of sections, and to get as good a contact as possible between the wheels and the rails. The collecting gear also should preserve a good contact, and all vibrations of the car or permanent way avoided as much as possible. The evidence in the various replies sent in seem to show that a rubbing collector is better than a revolving trolley wheel.

Return Conductors.—Mr. F. O. Rusling, the superintendent of the Buffalo Railway Company, has read a most interesting paper before the New York State Railway Convention on the use of old rails as underground conductors. In the Buffalo district trouble had occurred due to electrolysis. The water and gas pipes had suffered considerably, and at the two worst places these pipes were found to be from three to five volts positive to the adjacent rails. These two points were respectively about 1,500ft. and 1,800ft. away from the power-house. An expert called in calculated that some £1,600 worth of copper would be required as return conductors to remedy the fault. It then occurred to Mr. Rusling that some disused steel rails might be employed, and with the expert's concurrence the following construction was adopted for the shorter length. Four rails were used in parallel, they were flat, centre bearing rails, originally weighing 56lb. to the yard, but were worn down to 50lb. or less; they were high in carbon, hard and brittle. The rails were bolted together in pairs back to back and arranged so that the end of one rail was at the centre of its mate. The bonding was effected by scraping contact spots with a file near the end of each rail and amalgamating them with the Edison solid alloy. A steel washer ¼in. thick, 1⅜in. inside diameter and 4in. outside, was dipped into hot insulating compound and placed against one rail so as to enclose the contact spot. The hole in the washer was then filled with the Edison-Brown plastic alloy, enclosing an amalgamated steel spiral spring. The upper rail was then bolted on and the completed conductor lowered to the bottom of the trough, resting on one edge so that gravity would maintain the contacts. With this arrangement two of the bonds on any one rail would have to give way before the circuit could be broken; each bond was made sufficient to transit 1,500 amperes. When the second set of rails was lowered into place, the trough was filled with a hot insulating compound and a cover nailed down. This four-rail conduit was connected up and carried at heavy load 1,100 amperes 1,500ft. with a loss of but four volts. To produce the same effect with copper at 6d. per pound an expenditure of £590 would have to be incurred, while the scrap value of the old rails was computed to be only £80. This first

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return was found so satisfactory that one for the longer distance was put in hand. In this about 3,000 amperes had to be provided for, but 14 rails in parallel were employed. The author attributed the success to the bond used, and would not advise the employment of copper bonds for buried conductors.

Electricity in France.—Electricity as a motive power is becoming very generally recognised now on the Continent. Fresh companies and fresh schemes are continually cropping up, and we give details below of some of the latest projects. The French Thomson-Houston Company are about to commence the installation works of the electric tramways for the town of Alger. The generating works will be erected at the Pâté de Mustapha, and the machinery, in three groups, will have a capacity of 350 h.p. The energy will be furnished by three dynamos of 200 kilowatts each. The carriages will be supplied with two motors, one for each axle, and will accommodate 42 passengers. They will be lighted with five lamps of 16 c.p. The whole line is to be lighted by electricity at night. The fares will remain the same, and everything that the Algérois can desire is being done to give a prompt solution to the question. The company is bound to commence the works 45 days after receipt of the necessary authority, and it is estimated that five months at the most will be sufficient to carry it to completion. A presidential decree of September 11 last declared of public utility the establishment of an electric tramway in the department of the Rhône for the conveyance of passengers between the boulevard of the Croix-Russe, at Lyon, and the suburb of Caluire, to the right of the Rue Vignoles, near the Place de l'Eglise. The same treaty approves the agreement made between the Prefect of the Rhône and Mr. Alexandre Durand, in which the latter agreed to construct and exploit the line at his own risks, without a subsidy or guarantee of interest. After a considerable delay work has been commenced on the electric tramway at Besançon. The electric tramway is likely to be installed soon at Chalons-sur-Marne. The building of the works is commenced, and in a week or two the boilers and motors will be fixed. Steps are being taken to establish an electric tramway between the town of Hyères and the neighbouring municipality of Toulon. The Municipal Council of Marseilles is busy discussing this question of traction, arising from the proposal of the Compagnie Générale Française des Tramways to substitute electricity for animal power. The overhead wire is proposed, and the principal objection on the part of certain members of the Council seemed to be that the supporting columns might impede the traffic. The engineer to the company (Mr. Doux) allayed all apprehensions on that score, and the question will be again gone into. At Nantes, too, there seems to be great competition. Besides the works already in course of execution for an electric tramway, three companies have placed before the Municipal Council proposals for new lines. A somewhat natural sequence has followed on the establishment of the electric light at Oran; it has now been decided to lay down a network of tramways. At a meeting of the General Council of Drôme, Mr. Noyer proposed the construction of an electric railway between Taulignân and Chamaret. After a long discussion the proposition was referred to the Finance Committee. This concludes the list as far as France is concerned at present, but in many other towns the question is being agitated. At Grenoble, for instance, in the department of the Isère, the preliminary formalities have been concluded of a line which will run out into the suburbs, and which will have some great difficulties in the way of gradient to overcome. Grenoble is, so to speak, in the centre of a very hotbed of electricity. The unlimited and stupendous water power obtainable at innumerable points in the surrounding mountains makes electricity produceable at a cheap rate, and consequently the electrical engineer's trade is a flourishing one there. Some of the smallest villages even have their public installations, and the use of the light is being very rapidly extended in the mountainous districts.

Visible Electric Waves.—Mr. B. E. Moore communicates to the current number of the *Physical Review* an interesting account of some of his experiences. We believe that a somewhat similar effect was noted by Dr. Lodge soon after Hertz's discovery was published. Mr. Moore used a quadruple-plate Toepler-Holtz machine as his generator, and connected a three-quart Leyden jar to each pole. The other coatings of the jars were connected respectively to two wires about 8in. apart and 23ft. long. At the end of these was connected a Crookes tube. As is well known, with the apparatus arranged as above described and a powerful induction coil substituted for the Toepler-Holtz machine, one can locate the nodes of the electric waves by simply sliding a rider along the wires. As was rather expected, the rider placed at any point whatever along the wire obliterated the discharge through the Crookes tube. The room was darkened, with the hope that a slight glow could be obtained when the rider rested upon the node points. This led to an unexpected result. When the discharge occurred, the wires were aglow with the electric waves. (There was no rider across the wires.) The observer working the machine sees, at every discharge of the primary, the wires momentarily illuminated. But all parts of the wire are not illuminated alike. At some points of the negative wire, the circle of illumination is little larger than the wire itself. Halfway between two such points the circle of illumination is often 1½in. in diameter. The whole presents the appearance of a solid sine wave—not unlike the appearance of circularly vibrating strings. Looking at these waves from the side instead of from the end, the phenomena are different. The nodes and crests are distinct as before, but the illumination no longer appears continuous. In a plane normal to the negative wire a fine illuminated rectilinear discharge in the form of rays or pencils occurs. These rays are often branched. They radiate from the wire as a centre, and form a circle about the same, often 1½in. in diameter at the crest of the wave. At a distance of 2½in. to 4in. on either side of the crest appears another such illuminated circle. These circles diminish in size as the node is approached. The circumferences of these circles form the solid sine curve. The positive discharge was entirely different. The crests and nodes upon the positive wire were only apparent to a close observer, and were not distinguishable at all until the room was well darkened and a wood screen so placed as to cut off the light radiated by the Crookes tube. The circles of illumination so apparent upon the negative wire were entirely absent. The illumination of the wire was continuous, and confined almost to the surface of the wire. The light emitted by the crest of the wave seemed only more intense than that emitted by the node. Only those who had some experience in photometric measurements could easily detect a difference. The waves along the negative wire can be made visible to an entire audience by cutting off the light of the Crookes tube. The eyes should be protected from the spark of the primary discharge. However, shielding the wire from the light of the discharge is detrimental. The author states that this method of showing electric waves is particularly serviceable for lecture purposes. A general audience can more highly appreciate it, as no process of inductive reasoning is involved. The waves stand out vividly, and are no abstractions.

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THE PRINCIPLES OF ALTERNATE-CURRENT WORKING.*

BY ALFRED HAY, B.Sc.(EDIN.), A.I.E.E.

(Continued from page 375.)

73. The effect of inductance in an alternating-current circuit is a twofold one. It diminishes the current in the circuit by increasing the impedance, and it causes the current to lag behind the impressed E.M.F. as regards phase. This lag of the current behind the impressed E.M.F. gives rise to many remarkable effects. Some of these, which have been more particularly studied by Prof. Elihu Thomson, we shall now proceed to explain. The interest which attaches to these phenomena is not a purely theoretical one, for the principles underlying them have received a practical application in the construction of a number of alternate-current instruments.

74. Consider a conducting mass placed in a magnetic field, and let the field be made to undergo a change. During the time that the field is changing, E.M.F.'s are induced in the conducting mass, and give rise to currents in it. The direction of these currents is, by Lenz's law (Art. 24), such that they tend to oppose the change in the magnetic field which gives rise to them. Hence the conducting mass will tend to move (whether by a motion of translation, or by a motion of rotation) so as to prevent the change in the magnetic flux through it.

As an example, suppose that a short cylinder of metal L M is placed in the magnetic field shown in Fig. 55.

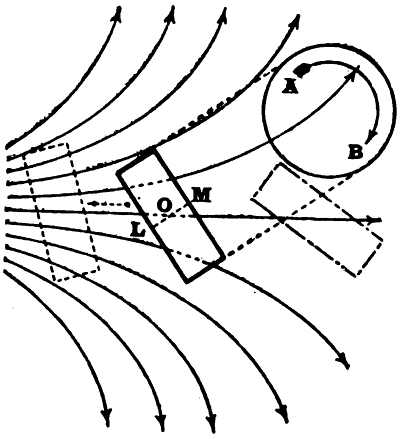

FIG. 55.

For the sake of simplicity, we shall suppose that the cylinder is suspended by means of a very long silk fibre attached to the point O. This will allow the cylinder considerable freedom of motion. Let the magnetic field be now weakened. The currents induced in the cylinder will have the direction indicated by the arrow A B when looked at from the side L of the cylinder. These currents will tend to move the cylinder so as to maintain the magnetic flux through it unaltered—*i.e.*, so as to produce by the motion an increase in the number of lines while the field is diminishing. Now, an increase in the number of lines passing through the cylinder may be brought about in two ways: (1) by a bodily movement of the cylinder into a stronger part of the field—hence the cylinder will tend to move bodily in the direction of the dotted arrow; (2) by a rotation of the cylinder about a vertical axis in such a direction that its plane faces tend to become perpendicular to the direction of the field. In other words, the cylinder will be acted on by a force and a couple; the first will produce a motion of translation, the second a motion of rotation, and the cylinder will be deflected and rotated into some such position as that shown dotted in the figure.

If we suppose that the field is increased instead of being diminished, then all the actions we have just considered will be reversed, and the cylinder will tend to swing into the position shown chain-dotted in the figure.

75. Let us next suppose that the magnetic field in which the cylinder is placed is made to alternate between two equal and opposite values. This effect might be produced by the pole of an alternate-current electromagnet held near the cylinder. For the sake of simplicity, we shall suppose that the magnetic flux through the cylinder varies according to the simple harmonic law. Let the curve A B C D E (Fig. 56) represent the variations in the intensity of the magnetic field. The rate of change of the magnetic field will be represented by another sine curve (shown dotted in Fig. 56) which is in quadrature with the first curve (Art. 22). Now since the E.M.F. induced in any circuit inside the cylinder is measured by the rate of change of the magnetic flux through it (Art. 23), it follows that all such E.M.F.'s will be represented by curves such as the dotted curve in the upper part of Fig. 56. Again, if the circuits along which the currents flow inside the cylinder were devoid of inductance the currents in them would be in phase with their respective E.M.F.'s. Hence the currents would also be represented by curves such as the dotted curve in Fig. 56, being in quadrature with the field. The force or couple due to any one of these currents would at any instant be proportional to the product of current and field intensity at that instant. But the mean value of two sine functions which are in quadrature with each other is zero (Art. 61). Hence there would be no resultant action on the cylinder, the successive

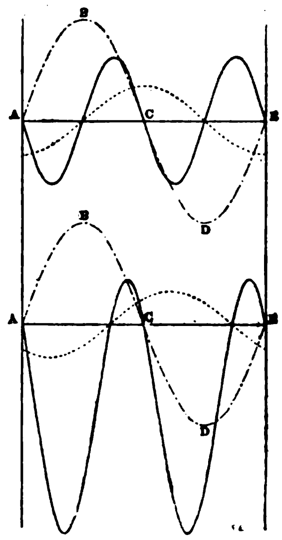

FIG. 56

impulses which it receives being represented by equal positive and negative half-waves, as shown by the full-line curve in the upper part of Fig. 56.

We know, however, that the circuits in which the induced currents flow in the cylinder have a certain amount of inductance. Owing to this fact, the currents, instead of being in phase with their respective E.M.F.'s, lag behind them. The dotted curve in the lower part of Fig. 56 is supposed to represent one of the currents, and it will be noticed that this curve lags behind the dotted curve in the upper part of the figure. The result is that now the successive impulses received by the cylinder are no longer balanced; the negative impulses considerably exceed the positive ones, as shown by the full-line curve in the lower part of the figure. On the whole, therefore, the cylinder will experience a negative force and negative couple, and it will tend to take up permanently some such position as that shown chain-dotted in Fig. 55. In other words, there will be an apparent *repulsion* of the cylinder by the pole of the alternating electromagnet, and the cylinder will tend to turn round so as to make the magnetic flux through it a minimum.

76. Instead of dealing with a large conducting mass placed in a variable field, let us next suppose that we have a simple rectangular frame of wire, A B C D (Fig. 57), suspended as shown in a field which is uniform,* and which varies as time goes on according to the simple harmonic

* Based on a series of evening lectures delivered at the University College, Liverpool.

* *i.e.*, which has the same value from point to point of the space considered. *Uniform* refers to *space*, *constant* to *time*. A field may be *uniform* and yet not *constant*.

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law. In accordance with the principles explained above, the frame will tend to move so as to reduce the magnetic flux through it to a minimum. Now since the field is uniform, a pure motion of translation would not reduce the magnetic flux through the circuit. The frame therefore simply tends to turn round so that its plane becomes parallel to the field. It experiences a couple due to the forces acting on the sides A B and D C. Let each of these forces be denoted by F, and let θ be the angle which the plane of the circuit makes with the direction of the field. We shall investigate for what value of the angle θ the couple becomes a maximum. Referring to the diagram

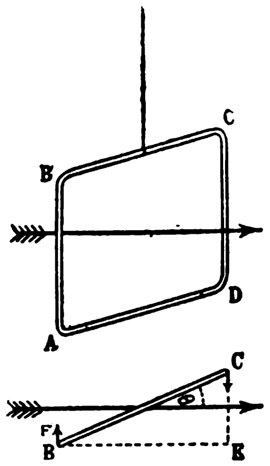

Fig. 57.

(Fig. 57), and denoting by c the couple acting on the frame, we have $c = F \times B\,E.$

Now F is, for a given field intensity, proportional to the current, and therefore to the E.M.F. induced in the frame; this E.M.F. is measured by the rate of change of the magnetic flux, and is therefore proportional to the maximum value of the flux. The latter, again, is proportional to E C; so that

$$c \propto E\,C \times B\,E$$

But $E\,C = B\,C \sin\theta$, and $B\,E = B\,C \cos\theta$ (Art. 6). Hence, since B C is a constant,

$$c \propto \sin\theta \times \cos\theta,$$

or, $$c \propto \sin 2\theta,$$

since by Art. 8, equation (8), $\sin 2\theta = 2 \sin\theta \cos\theta$. The greatest value of the couple will therefore be obtained by placing the frame in such a position that $\sin 2\theta$ has the greatest possible value. But the greatest value of the sine of an angle is 1; and the corresponding value of the angle is $\frac{\pi}{2}$ (a right angle). Hence θ must be made equal to 45deg. if the couple experienced by the frame is to be as great as possible.

77. A galvanometer for measuring very small alternating currents has been constructed by Dr. Fleming, in which

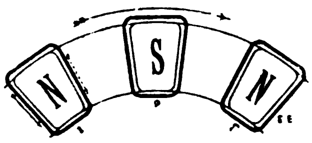

Fig. 58.

the above principles are made use of. It consists of a coil of wire, inside which is suspended a small disc of copper whose plane makes an angle of 45deg. with the axis of the coil. The couple acting on the disc is proportional to the product of the current induced in it into the field intensity. But the induced current is itself proportional to the field intensity. Hence the couple acting on the disc varies as the *square* of the field intensity—*i.e.*, as the square of the current through the galvanometer coil. If we suppose that the deflections of the disc are small, so that the couple remains practically unaltered by the displacement of the disc, then we see that the deflections of such a galvanometer are proportional to the *square of the current.*

A number of other instruments have been devised whose action depends on the principles explained above.

78. Before dismissing this subject, we shall consider the effect of phase difference between armature E.M.F. and current on the field of an alternator. Let, in Fig. 58, N S N denote the polar projections of an alternator, and let 1, 2, and 3 be three positions of an armature coil. The E.M.F. passes through its zero value when the coil occupies the positions shown. Between the positions 1 and 2 the direction of the E.M.F. is that shown by the full-line arrow; between 2 and 3, that shown by the dotted arrow. The positions of the coil indicated in the figure are those in which the armature current can most readily affect the field, since the coils in these positions are facing the polar projections. If the armature current is in phase with the E.M.F., then, on the whole, it exerts no strengthening or weakening effect on the field; for in the positions of the coils calculated to produce the greatest reaction on the field, the current passes through its zero value; and in other positions of the coils such weakening effects as are produced when a coil is approaching a pole are balanced by equal strengthening effects when the coil is receding from the pole.

Suppose, however, that the alternator is working on an inductive load, and that consequently the current lags behind the E.M.F. In this case, when the coil is in the position 1, there is a current flowing in it, whose direction is indicated by the dotted arrow. The coil will therefore exert a demagnetising effect in this position, and this effect will increase with the lag of the current. We thus see that a *lagging* current *weakens* the field of an alternator.

Again, let us suppose that the current is in advance of the E.M.F. as regards phase. Then the action will obviously be reversed, and hence a *leading* current *strengthens* the field of an alternator.

Corrigendum.—On page 342, Art. 62, line 6 from beginning of article, the sentence, "This storage of energy . . . and returned to the source of alternating E.M.F.," should read as follows: "The storage of energy *due to this component* goes on so long as the component is increasing; when it reaches its maximum value, the storage due to it ceases; and during the next quarter-wave, when it is decreasing, the energy stored up by it is discharged from the circuit, and returned to the source of alternating E.M.F."

(To be continued.)

RAILWAY BLOCK SIGNALLING.

BY J. PIGG.

(Continued from page 400.)

In addition to the operations described, the placing of the signal lever in the "off" position breaks the connection of the locking electromagnet with the line wire to the advance cabin, and connects it with the special circuit and battery to the rail treadle (up-line instrument at "C," Fig. 75). Remembering that the apparatus locks the signal lever in the "off," as well as in the "position, on"

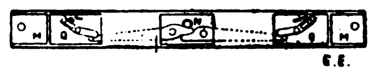

Fig. 73.

and that "locked" appears at the upper opening at this stage of the operations, it will be seen that it is impossible to release the armature, A, by a current from the advance cabin quite irrespective of the locking of the plunger at that place consequent upon its use to release the armature in the first instance. In addition to the apparatus described, the system includes a mercury contact rail treadle (Fig. 73), in which the contacts are made by the tilting of the vessels containing the mercury, consequent upon the depression of the rail acting through a plunger on the short ends of two levers to the longer arms of which the vessels containing

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the mercury are connected. There is also an automatic arrangement for replacing the signal arm in the "on" position by the passage of the train over the treadle irrespective of the position of the lever operating the signal under normal conditions. The automatic signal replacer is shown by Fig. 74. The rod actuating the signal is attached directly to the upper part of the box containing the apparatus, and the slide bar, *f*, is worked by the lever

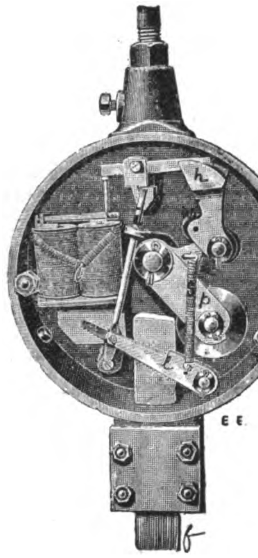

Fig. 74.

from the cabin. The normal position of the sloped upper end of *f* is under the lever *l*, in which case the slot on the upper surface of *l* engages with the slot on the lower surface of *p*, the latter being pulled into a vertical position by the spring, *s*. Under these conditions the box and the apparatus it contains work with the movement of the signal lever, the upward movement being transmitted from *f* through the levers, *l* and *p*, to the case and the rod working the arm, and the downward movement by the greater weight of the box and rod as compared with that of the signal arm outside the centre on which it turns. If the electromagnet is energised, the hammer, *h*, is released and falls

Consideration of the illustrations, and description of the functions of the various pieces of apparatus forming the system, will show that the objects aimed at in the design do not differ materially from those of other systems, but the arrangement of the apparatus is novel, and the electrical devices are of the simplest possible character. Fig. 75 is a diagram of the connections for a simple block section such as is shown by Fig. 9; but the block bell connections are omitted, as they differ in no way from those described in connection with the three-wire single-needle system, and are entirely independent of the block indicators and locking apparatus. The paths of the currents will be easily traced from Fig. 75, which is drawn to represent the positions of the apparatus on the assumption that a train is passing through the section from "B" to "C" on the up line. This train has been accepted by D as shown by the horizontal position of the semaphore arm of the up-line instrument working from D; and the change in the connections of the electromagnets shows that the starting signal at "C" is "off," whilst the position of the armature and the "locked" indication exhibited show that the signal lever is locked in the off position. The indication "Train on" at "C" shows that the plunger has been used to liberate "B's" signal, and is itself now locked. The position of "B's" electromagnet connections and the "locked" indication exhibited show that the train has passed over the treadle at "B," and that the signal lever has been placed in the "on" position; whilst the position of the switch, T, at "B" indicates that the train has not been cleared back to "A," or that "B" has undertaken shunting operations involving the fouling of the running line inside the starting signal. The switch, T, in the position shown at "B's" up-line instrument would embrace the plunger rod and prevent it being used inadvertently.

The novel arrangement of the battery used in operating the plunger is intended to minimise the chance of inconvenience being caused by failure of the battery or its connections. The batteries act in parallel when in use, and the connections to the battery terminals in the instrument are duplicated. Of course the chance of failure with two batteries, each capable of doing the work, is much less than with one battery alone. As shown in Fig. 75, however, failure of the battery earth would render both batteries inoperative, and it would therefore be necessary to carry

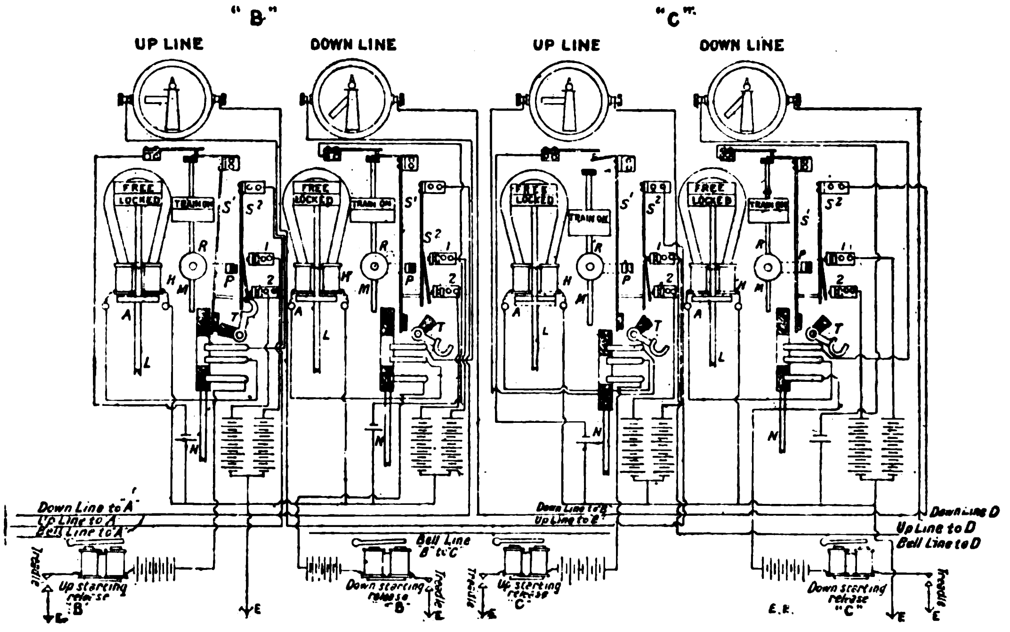

Fig. 75.—Sykes's Lock and Block.

upon the rod, *i*, and disconnecting the two slotted levers, *l* and *p*, allows the box to fall and place the arm at danger. The wheel, *w*, is pressed outwards by the sloping end of *f*, and causes *p* to turn on its centre. The Λ-shaped projection of *p* engages with the wheel, w_1, on *h*, and causes the latter to assume its original position. When the signal lever is placed in the "on" position, the slide, *f*, is lowered, and *l* engages with *p*. The apparatus is then ready for further use.

the duplication of connections to the fullest extent in order to secure all the advantages accruing from the use of duplicate batteries.

Fig. 75, as stated, represents the arrangements for working the simplest possible block section only. For junction working the arrangements have necessarily to be more complex. For such a junction as Fig. 11 represents releasing treadles are required for each of the *diverging* lines, and each treadle must be capable of working the

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same instrument. For the lines *converging* at the junction the plunger used to liberate the signal at the rear cabin of any one of the converging sections is arranged to be free for use only when the points have been set for a train coming from that direction. This, of course, with the usual signal and points interlocking would mean the control of each plunger by the "home" signal for that section, and would ensure all other signals for lines converging there being at danger. Only one treadle would be required for trains coming from any of the converging lines. The arrangements for special cases like junction working will, however, depend greatly upon local conditions, and it is not possible to give more than the barest outline of the arrangements for such cases.

Circumstances will, however, sometimes arise in apparently simple cases which would seem to indicate the necessity for more elaborate arrangements than are shown by Fig. 75. Fig. 10 is a very simple block station, but if we assume the arrival of a train at that place with a bare time margin in front of a more important train, the necessity for shunting the first will arise. If the releasing treadle is placed at or in advance of the "advance" signal, and there is only one treadle, the train which is to be shunted will require to actuate the treadle—in which case it may actually be in the advance section—before the starting signal (which is assumed to have been lowered) can be replaced. If the starting signal has not been lowered, the signalman knowing the train will require shunting, then some further arrangement will be required to release the plunger in order to use it to enable the second train to advance when the first has been safely shunted. Further consideration of the same case would suggest the possibility, with only the arrangements described, of the shunted train being afterwards allowed to proceed to the "advance" signal, and of a second train being brought into its rear from the rear cabin, since the starting signal being "on" the plunger would not be *absolutely* locked. Of course, the case cited would be readily met by establishing control of the instrument with the siding points levers, or even control of the switch-handle, T, with the same lever, but the case is given simply to show that in apparently simple cases the arrangements for complete safety against the results of carelessness or neglect must be more elaborate than would seem necessary at first sight. Further consideration of the apparatus suggests the possibility of the starting signal being unlocked by contact of the block instrument line wire with another working wire on the same route, and this, in combination with other circumstances, not altogether unknown in railway work, might result in two trains being in the section on one line of rails together. This, of course, is by no means peculiar to the instrument just described, but is common to all classes of instrument in which the movements resulting in the release of locking apparatus or the setting of the indicators in their more important positions, are due to one person only. Of the various classes of instrument described in these articles, only two, Preece's and Winter's—two instruments which have much in common—take notice of the effect likely to be produced in this way. Whilst the danger of serious results from such causes is very much less now than a few years ago, owing to improved construction of lines and greater vigilance in maintaining them in an efficient condition, yet line contacts are not entirely things of the past, and, as has already been remarked, the history of railway accidents is full of instances of curious combinations of circumstances which would appear as most improbable of simultaneous occurrence. In this system, as in others of a similar kind, cancellation of a signal which has resulted in the preparation of the line for the passage of an approaching train can only be done by special means, which may or may not be immediately available for use by the signalman, and the use of which is an infringement of the automatic character of the apparatus. In some cases cancellation is directly prohibited, and the replacement of the apparatus in its normal position is made by the next train in that direction, it being worked through the section at "caution" in consequence of the defect in the apparatus. Probably such a regulation would do much to promote care in the despatch of signals asking for the clearance of apparatus for an approaching train, seeing that every lapse and the consequent delay would have to be fully explained.

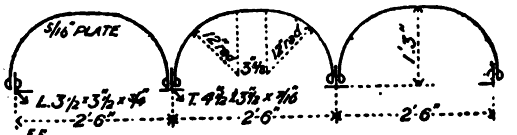
The system, like others, whilst providing for the automatic clearing of the section by the passage of the train itself, makes no provision for automatic notification of the *entrance* of the train into the section at either of the cabins controlling it. Yet, surely, if it is undesirable for the signalman at the receiving end of the section to trust entirely to his observation for guidance in clearing a section, it must be equally undesirable for him to trust to the signalman at the sending end for notification of the entrance of a train; and circumstances might easily arise where such independent notification would be of the utmost value to the signalman at the receiving end of the section in the event of an unauthorised train entering a section through the prevalence of fog or other similar cause.

(To be continued.)

LIVERPOOL OVERHEAD RAILWAY.*

BY S. B. COTTRELL, M.I.C.E., M.I.M.E., ENGINEER AND GENERAL MANAGER.

For many years before this railway was constructed, the want of proper facilities for conveying passengers to and from the docks was badly felt, the only direct means of conveyance being by means of omnibuses, which badly met the requirements. In 1852 a proposal was made to have a high-level railway from the Mersey forge to the Huskisson Dock—a length of about four miles—but nothing came of the proposal. About 17 years ago the Mersey Docks and Harbour Board felt that the question of better means of communication to the docks required to be seriously considered, and after careful investigation of the elevated system in New York, Mr. Lyster, M.I.C.E., prepared plans and estimates. In 1882 an Act was obtained by the Dock Board for the construction of the railway at an estimated cost of about £585,000, which was subsequently reduced to £466,000 for a system worked by electricity. In 1888 the power to construct the railway was taken over by the present Overhead Railway Company under the chairmanship of Sir Wm. B. Forwood, and the works, as designed by the engineers, Sir Douglas Fox and J. H. Greathead, Esq., MM.I.C.E., were commenced by the contractor (the late Mr. Willans) in 1889.



SECTION OF FLOORING

FIG. 1.

The railway extends the full length of the docks, and with the northern extension (opened in 1894) and the southern extension (under construction) will connect the suburbs of Seaforth and Waterloo with those of Princes and Sefton Parks. The construction decided on was wrought-iron girders, placed 22ft. centre to centre, at a normal span of 50ft., at a height of 16ft. above the roadway, supported on columns which are built of two steel channels and two plates. The columns are grouted into cast-iron shoes, which are held down by bolts to concrete foundations, the size of which varied according to the nature of the ground, the weight being distributed at one ton to the square foot. The bottoms of the columns are protected against injury from passing wagons by cast-iron bumpers. The longest span on the present railway is a bowstring span of 98ft. The main girders carry a light projecting parapet, and a curved plate is put on the flange to form a continuous footplate. Between the girders is fixed a continuous flooring made of arch plates 5-16in. in thickness, bent to a radius of 12in., with a foot surface 16in. wide on the top, riveted to intervening tee bars. The flooring is made watertight by means of asphalte channels between the arches, which are drained by outlets into longitudinal gutters which discharge into downspouts fixed on the columns. The keeping of the structure watertight was one of the obligations the company were under. The flooring (Fig. 1) combines great strength with lightness and a minimum of riveting, and at the same time is comparatively noiseless under traffic. The structure was so designed that the girders and flooring were put together and riveted, and then transported over the structure after it was completed (a few spans being

* Paper read before the British Association at Liverpool.

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first erected in the ordinary way), and placed in position without interfering with the traffic underneath. For this a special form of erecting apparatus was provided, consisting of lattice girders supported on legs, the front pair of which travelled on the ground and hind pair travelled on the viaduct that was already built. On these lattice girders suitable cranes were erected, so that the completed span could be launched forward into position. As many as 12 spans, ranging from 50ft. to 70ft. each, were fixed in 5½ working days, representing 650ft. of finished viaduct.

At four different places along the line opening bridges had to be provided. At the Stanley Dock a hydraulic swingbridge is built to enable vessels to pass to that dock, which is the only dock on the east side of the railway. This bridge is a double-decked one, carrying the Overhead Railway on the high level and the dock traffic on the lower level. The low-level bridge is arranged with bascule leaves, so that barges and small craft can pass through without swinging the bridge. At three other points bascule bridges, worked by hydraulic power, are provided to permit the passage of boilers, etc., which are too high to go underneath the main girders. The permanent way, which is laid to a gauge of 4ft. 8½in., consists of flat-bottomed steel rails weighing 56lb. per yard, fixed on longitudinal sleepers, held down to the flooring by lugs riveted on to it and keyed in with oak keys. The rails are fixed to the longitudinal sleepers by spikes and fang bolts.

After careful consideration, electric traction was decided on, and trains were built consisting of two carriages, each 45ft. long, 8ft. 6in. wide, on two bogies 32ft. apart from centre pin to centre pin, with 2ft. 9in. wheels. Each carriage contains seating accommodation for 16 first-class and 41 second-class passengers. The carriages have side doors and passage from end to end. Each carriage is fitted with electric motor, and the train is controlled by a driver from either end; this avoids all shunting at the terminal stations, the driver simply changing from end to end. The armatures for the motors are series wound (on the Eickemeyer system), and built directly upon the axle. The tractive force of each motor at rim of wheel, 2ft. 9in. diameter, with 120 amperes, is about 1,790lb.—equal to about 107lb. per ton of train. The motors are started up first in series, and then switched into parallel through a resistance with each motor, which is cut out to increase the speed. The trains pick up the current from a conductor consisting of a steel bar, having an area of four square inches, supported on insulators carried on cross-timbers between the two running rails. The conductor is laid in 32ft. lengths connected with rigid copper fishplates with flexible joints every 96ft. The running rails which are used for return electrical circuit are, in addition to the fishplates, coupled together with a bent wrought-iron bar, and give a section of 22 square inches. Short trains, as described, run at frequent intervals, have proved up to the present time the best means of meeting the requirements. The trains are fitted with the Westinghouse automatic brake, supplied with compressed air at 80lb. pressure from reservoirs on trains, which are charged at the terminal stations; they also have an emergency hand-brake. A train fully load weighs 38 tons, of which the motor equipment is 6 tons 7cwt. The carriages are lighted by 32-c.p. incandescent lights, supplied from the main conductor.

The generating station was put as near the centre of the line as a site could be obtained, and the first equipment consisted of six double-flue Lancashire boilers, 30ft. long by 8ft. diameter, with a pressure of 120lb. The feed-water is circulated through Green economisers, and all steam-pipes are in duplicate. The engines are four in number, consisting of horizontal compound condensing engines, by Musgrave and Sons, of Bolton; the high-pressure cylinders being 15½in. and low-pressure 31in. diameter, fitted with Corliss valves, driven by trip gear acted on directly by the governor. Each engine develops 400 i.h.p. at 100 revolutions per minute, with 120lb. boiler pressure. The engines exhaust into surface condenser, the circulating air-pump for which is driven by a no-dead-centre vertical compound engine. The condensing plant is in duplicate. Each engine drives an Elwell-Parker dynamo, 500 amperes, 500 volts (of the double-limb type), with magnetic circuit above and below the armature, the poles being cut through horizontally along the centre to allow the top half to be lifted readily; they are shunt wound of drum type. The efficiency of the dynamos and engines is about 85 per cent. at full load. The current from the dynamos is controlled by a switchboard, which is equipped with magnetic cut-outs, which work automatically in case of a short-circuit, by which the current is conveyed to the centre conductor, and is picked up by collectors of cast iron, fixed underneath the trains. The stations on the original line, 13 in number, subsequently increased to 16, are lit by electricity from batteries in duplicate on a 50-volt circuit, which also supply the current for working the signals.

Signals.

The signals (Fig. 2) are automatic (Timmis system), the arms being operated by magnets, which are controlled by makers and breakers operated on by a striking board fixed on the last coach. The train in passing either breaks the circuit and puts the arm to danger, or makes the circuit and lowers the arm. Each station is equipped with a "home" and a "starter," the latter acting as a "distant." The circuit to lower the signals for the section in the rear of any station can only be completed if the "starting signal" is at danger—thus forming "absolute block." A train on leaving a station passes a breaker and puts the "starter" to danger, and after moving about 150ft. passes a maker, which completes the circuit and clears the section in the rear, leaving itself protected by the "starter." This system dispenses with signalmen, they only being employed where shunting operations are carried on. Each station is equipped with a crossover road interlocked with the signals. The total cost of the first portion of the railway, 5¾ miles in extent, was £90,000 per mile. The earning power of the railway as at first constructed, and which was only worked for traffic as far as the Alexandra Dock, was limited, as passenger traffic on the docks practically ceases at 6 p.m.; and this the directors foresaw, and in 1892 obtained powers to extend the railway both in a northern and southern direction. The northern extension, a quarter mile in extent, but opening up another three-quarters of a mile for traffic, was opened as far as Seaforth in 1894, and fully justifies its construction, the number of passengers carried having increased from 2,475,639 for the six months ending December 31, 1894, to 3,780,375 for the six months ending December 31, 1895.

Southern Extension.

The southern extension, five-eighths of a mile long, which is now in course of construction, commences about 150 yards north of the present terminus of the railway, with a viaduct 250 yards long, crossing Sefton-street and the Brunswick goods yard of the Cheshire Lines Railway, a portion of the Dock Board Estate, and entering the hill side at the north-east corner of the Herculaneum Dock, and proceeds in a south-easterly direction to Park-road. To meet the requirements of the Dock Board their land is crossed by one span of about 200ft., the main girders (which are of lattice type with parallel booms) being 220ft. and 225ft. respectively, and the whole of the span will weigh about 212 tons. Underneath where these big girders will rest at the face of the tunnel are casements for storing petroleum, belonging to the Dock Board, extending about 60ft. into the hill, and to distribute the weight of the span over these a bearing girder weighing 10 tons has been let into the rock, and on this girder the east end of the span will rest. The west end will rest on a pier provided with rollers and rockers. The normal tunnel has a span of 26ft. 2in. springing to springing, and 25ft. 6in. between side walls with a splayed plinth course; the arch is semi-circular. The tunnel for the station ground is 52ft. span, the arch being segmental, having quarter-span rise.

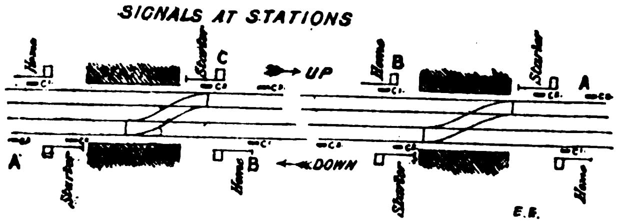

Fig. 2.

C^1, C^2, C^3 are contacts placed on brackets alongside the girders.
A Train passing over C^1 puts Home Signal to danger.
,, ,, C^2 puts Starting Signal to danger.
,, ,, C^3 pulls off Home Signal and Starting Signal of the Section in the rear.

The tunnel is under house property the entire length, and it was therefore not always possible to sink shafts where they were desired. Five shafts 10ft. square were sunk, from the bottom of which headings 11ft. and 12ft. were driven in each direction, and the greatest error in line and level was under ⅝in. The tunnel portion—about 800 yards—is almost entirely through red sandstone rock, which, like most of the rock in the neighbourhood of Liverpool, is of a very treacherous character. Heavy backs and wet clay beds being frequently met with, necessitating heavy timbering, a large number of the crown bars had to be built in. The tunnel has therefore had to be lined throughout its entire length; all the lining is faced with brindle bricks built in cement. Black powder has been the chief explosive used in the excavation. At about 170ft. from the entrance the tunnel crosses at an angle of 28° 27′ 40″ over the tunnel of the Cheshire Lines Committee Railway, through which the trains of the M. S. and L., G. N., and Midland Railways run, and the greatest distance that could be allowed between the overhead rails and the crown of the Cheshire Lines tunnel was 2ft. 9in.

After careful consideration the engineers decided that the only safe way to effectually make the crossing was by turning a segmental screen arch, five rings thick, built with brindle bricks in cement, over the Cheshire Lines arch, and to build the side walls of the overhead tunnel on this screen arch. This

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was carried out as follows: A top heading 120ft. in length was driven along the crown of the Cheshire Lines tunnel, and then 8ft. lengths were excavated, baring the Cheshire Lines arch for that length. The exposed arch was then haunched with concrete and the screen arch turned on sand, with ½in. narrow boards placed on it, and when the arch was set the sand and boards were withdrawn, leaving a clear space of 6in. over the Cheshire Lines arch, so that no additional weight would come on the Cheshire Lines tunnel. During these operations all the rock above had to be carried on timber. To guard against possible fall of rock which might crush through the Cheshire Lines arch, before commencing the above operations a shield was put inside the Cheshire Lines tunnel. This shield was made of 8in. by 5in. H steel joists at 4ft. 3in. centres, bent to the radius of the tunnel, and carrying 4in. laggings, and keyed up tight by means of folding wedges to the soffit of the arch. The Overhead Railway Company had also to provide for the Cheshire Lines at some future time having to construct another tunnel on the east side of their existing tunnel, and to avoid any interference with the traffic during the future it was decided to build a length of tunnel arch seven rings thick, on which arch the Overhead Railway side walls are carried. All the excavation for this crossing has been done entirely by hand labour, and has proved a most expensive and anxious piece of work. Further on the tunnel passes under a 5ft. by 3ft. sewer, and to avoid disturbing this the arch was altered from semi-circular to segmental, which just permitted with care the sewer to be underpinned. The trains on entering the tunnel will be automatically lit up from copper conductors suspended from the roof of tunnel, collectors being fixed on the roofs of the carriages. These lights will be fed off accumulators, so that if a train should be stopped in the tunnel due to short-circuit on the line, the carriages will not be in darkness.

The terminal station of this extension is situated at Park-road, otherwise called the Dingle, below the road level. The underground station will consist of an island platform about 27ft., with suitable sidings for accommodation of the trains. The station will be ventilated by a large up-cast shaft. The access to the station will be by means of a subway at a gradient of 1 in 14. The booking offices will be on the road level. The station will be lit throughout by electricity, the underground portion by arc lamps at 110 volts, supplied by a transformer off the main current. Battery lights will be provided in the event of a short-circuit on the line. As the station platforms are considerably below the level of the sewers, the question of dealing with the drainage of the tunnel and sewage of water-closets and urinals had to be considered, and it was decided to employ Shone's hydro-pneumatic system. The drainage and sewage gravitates to the ejector, which is 50ft. from the surface, and gradually rises until it lifts the balance spindle which opens the compressed-air admission valve. The compressed air thus automatically admitted into the ejector presses on the surface of the sewage, driving the whole of the contents of the ejector into the sewer, and this is repeated automatically. The compressed air does not follow the sewage into the rising main which conducts the sewage into the Corporation sewer 50ft. above, but is at once exhausted from the ejector by the automatic action of the spindle, the great advantage being that no such straining of the sewage as is necessary for the proper working of ordinary pumps is required for the efficient working of the ejector. The capacity of the ejector is 50 gallons, and the quantity dealt with per minute will depend upon the amount of sewage and drainage water coming down. If necessary, the ejector would fill and discharge four or five times per minute. The compressed air will be supplied from a compressor which will also charge the trains with air, the pressure being reduced for the ejector from 80lb. to 20lb. The permanent way and main conductor will be of the same section as on the present railway, but the rails are laid on the usual cross sleepers with cast-iron chairs to distribute the pressure.

As more generating plant will be required to work the additional number of trains, it was decided to increase the size of the present generating station, and to run feeding cables a length of about two miles so as to regulate the E.M.F. instead of building another generating station, as it was found that this method would cheapen the working costs. The addition to the generating station consists of two engines built by Messrs. Hick and Hargreaves, and two new dynamos and switchboard built by Messrs. T. Parker and Co., of Wolverhampton. The two new engines are Corliss valve engines, each of the horizontal surface-condensing type, having cylinders 15½in., 31in. by 3ft. stroke, each intended to give 400 i.h.p. as an economical load when running at 100 revolutions per minute, with a boiler pressure of 120lb. per square inch. The engines are of ample proportions throughout, and are fitted with a steam-jacketed receiver between the cylinders containing boiler pressure steam. The beds are of the box type, and of heavy section. The flywheels are 14ft. diameter, and are grooved for 19 ropes, each 1¼in. diameter. The condensing apparatus is a separate plant, having its own air and circulating pumps. Among other features of the new engines are, first of all, the construction of the cylinders, which are of the four-valve Corliss type, and which, instead of being cast in one piece, as is usual, are each built up of four principal castings—namely, a working barrel, a jacket, and two end pieces containing the circular steam and exhaust valve chambers—thus substituting four comparatively simple castings, which can each be cast of the mixture most suited to its purpose for a single casting of so complicated a character that it can only be cast of a comparatively soft mixture, and it is even then liable to failure from initial stress aided by unequal expansion. This sub-division not only reduces the chance of disablement, but should such occur the defective part may be replaced with much less expense and delay than a complete cylinder. Both cylinders are thoroughly steam jacketed, the steam traversing the jackets on its way to the respective cylinders. The governors are rope driven, and are of a new design, especially intended to combine the powerful governor with one of great sensitiveness for dealing with great variations of load (a diagram is given showing fluctuations in load, see Fig. 3).

The output of each dynamo is 500 volts, 500 amperes, at a speed of 420 revolutions per minute. The armatures are so arranged as to be interchangeable, identical in the matter of external dimensions with the existing ones; the resistance from brush to brush measures ·010 ohm. The magnets, however, instead of being of the double horseshoe type as in the present machines, are of a single horseshoe, with the poles at the top. This has resulted in an increase of efficiency, the shunt resistance being now 100 ohms as against 75, making an electrical efficiency of 98 per cent. The loss in hysteresis, eddy currents, windage, etc., amounts to 6,000 watts, so that the commercial efficiency at full load will be about 95·7 per cent. The magnets are of special magnetic steel of the highest permeability, and are arranged with the patent hinged pole-pieces. This allows of ready access to the armature for inspection, cleaning, or lifting without the necessity of unsetting the bearings. The dynamos are rope-driven by 19 1¼in. ropes, the rope pulley running between two bearings and the pulley shaft being connected to the armature by a coupling, so that the armature can be changed without disturbing the ropes. The bearing at the commutator end of the machine is of the spherical type. The diameter of the shaft through the bearings is 5in., the length of each bearing being 1ft. 5in. The brushes are of phosphor-bronze lined with white metal, the top brasses of each bearing being slotted to receive two lubricating rings, the bottom brass being continuous. The total weight of the machine is 24½ tons, the armature being 3 tons 2cwt. The steel magnet casting alone, without winding, is 12 tons.

The main switchboard consists of six slate panels, with sets of switches and instruments—one set for each dynamo in generating station. Each panel is fitted with one patent double-pole automatic magnetic cut-out, with plate-glass shields to protect the attendant from the arc in case a short-circuit on the line causes the cut-out to open with excessive load. These cut-outs are also employed as main dynamo switches, being made and broken by hand for connecting the individual dynamos to the omnibus bars. The magnets of the cut-out are compound wound, so that the circuit is broken immediately in case of a reversal of current. One single-pole throw-over switch for connecting the dynamo circuit (beyond the automatic cut-out) either to the omnibus bar, which feeds into the central conductor at the nearest point to the generating station, or through a feeder to a distant point on the line to equalise the E.M.F. One 33-way sliding, regulating switch to vary the resistance in the dynamo shunt circuit for maintaining the E.M.F. of each dynamo constant. One set of double-pole plugs for connecting voltmeter to dynamo before paralleling. One "Weston" ammeter, indicating the current passing from each dynamo to the line. The slate slabs are held on wrought-iron framework, all connections at the back being of heavy cast-bronze rods, supported on pillars, so that all straps and connections are accessible, no insulated cable being employed. The front of the board is finished off with massive teak carved pillars and panels.

Besides the instruments already described there are four "Weston" voltmeters, with illuminated dials, and an engine-room clock supported on panelled framework above the slate slabs. The voltmeters are arranged as follows: one connected directly across the omnibus bars; one for connecting at will to any dynamo by means of plugs to take E.M.F. before paralleling; one for connecting across brushes of the dynamo running on the feeder circuit; one as pilot voltmeter connected to the distant point in the line where feeder is coupled.

To meet the increased traffic that is expected from the southern extension, new rolling-stock is being built by Messrs. Brown, Marshall, and Co., and as the number of passengers carried is now over 7½ millions a year, the directors have found it necessary to increase the size of the trains by composing them of three carriages instead of two. In fact, last half-year (excluding bank holidays) an average of 60 per cent. of the seating accommodation of the trains was occupied. The new motors built by the Electric Construction Company are very similar to those at present in use, their strength being increased

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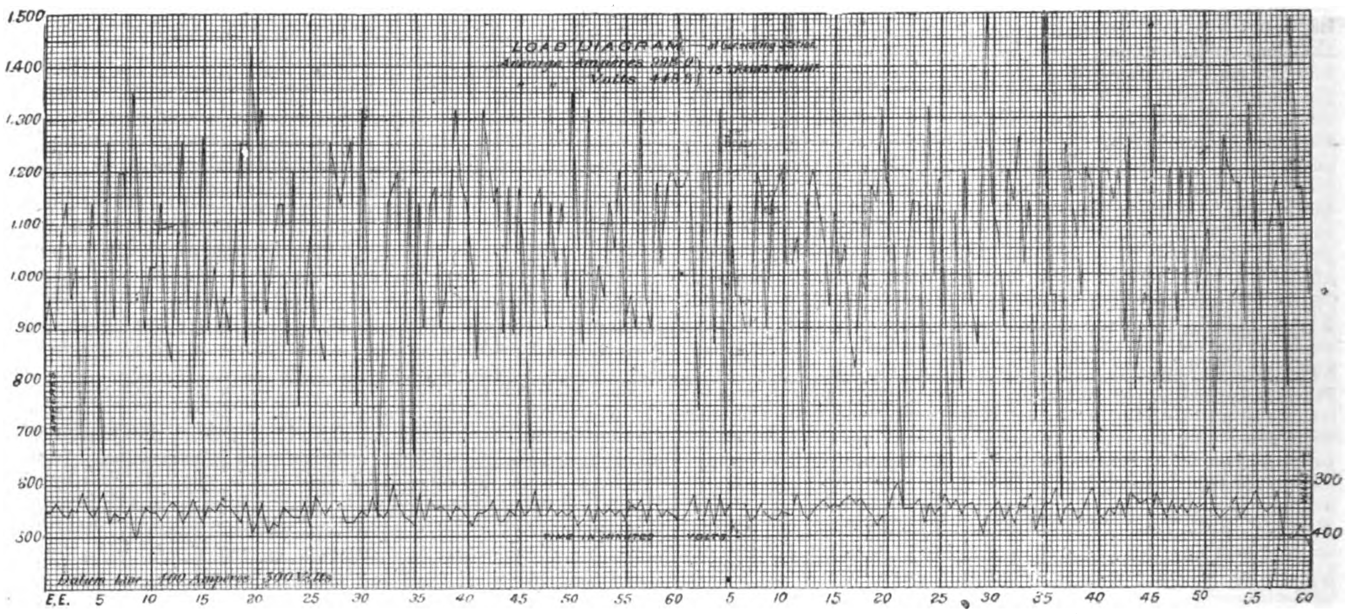
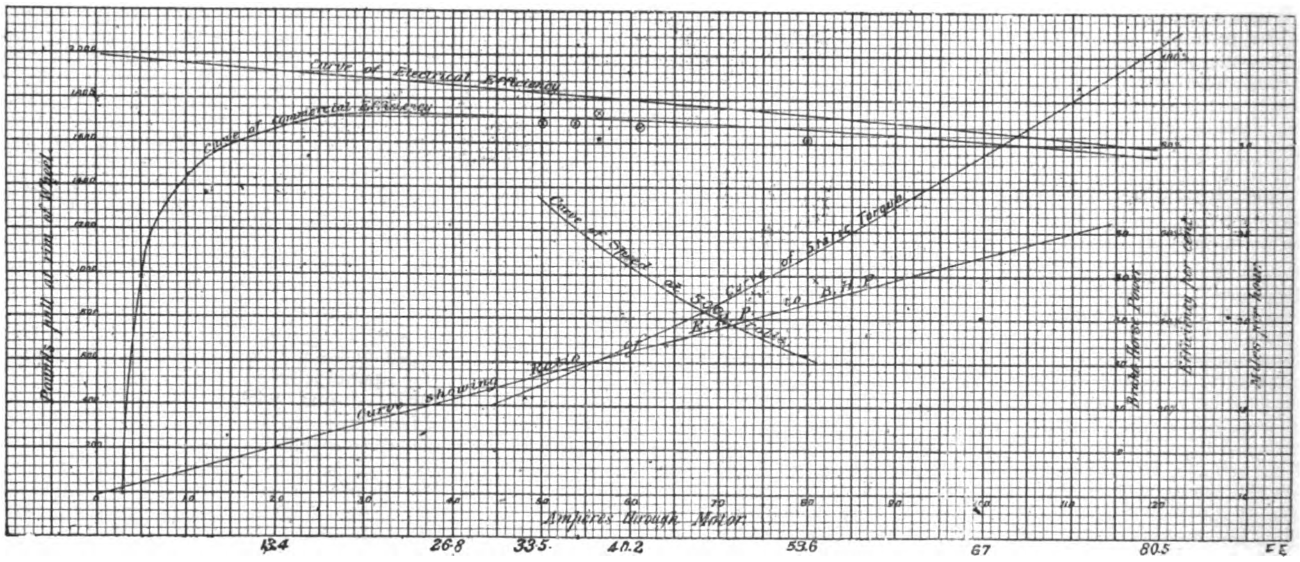


Fig. 3.



Electrical Horse-Power delivered to Motor, corresponding to above Amperes at 500 Volts.

Fig. 4.—Curves of Torque, Efficiency, and Speed of Liverpool Overhead Railway Motor.

Static Torque Curve, taken in usual way, by bolting lever on shaft, and weighting it at measured distances along it, till pull of current through motor is balanced.

Electrical Efficiency Curve takes into account the C^2R losses in the copper only. Resistance of armature and magnets in series is ·83 ohm, at a temperature of about 70deg. F. above atmosphere.

Commercial Efficiency Curve shows actual efficiency of motor at wheel, and is obtained by estimation of all the losses separately. The motor was made to drive a dynamo by a belt. The small discrepancy between these points and the Commercial Efficiency Curve is accounted for by the necessary approximate allowance made for belt, though this was as accurate as circumstances would permit.

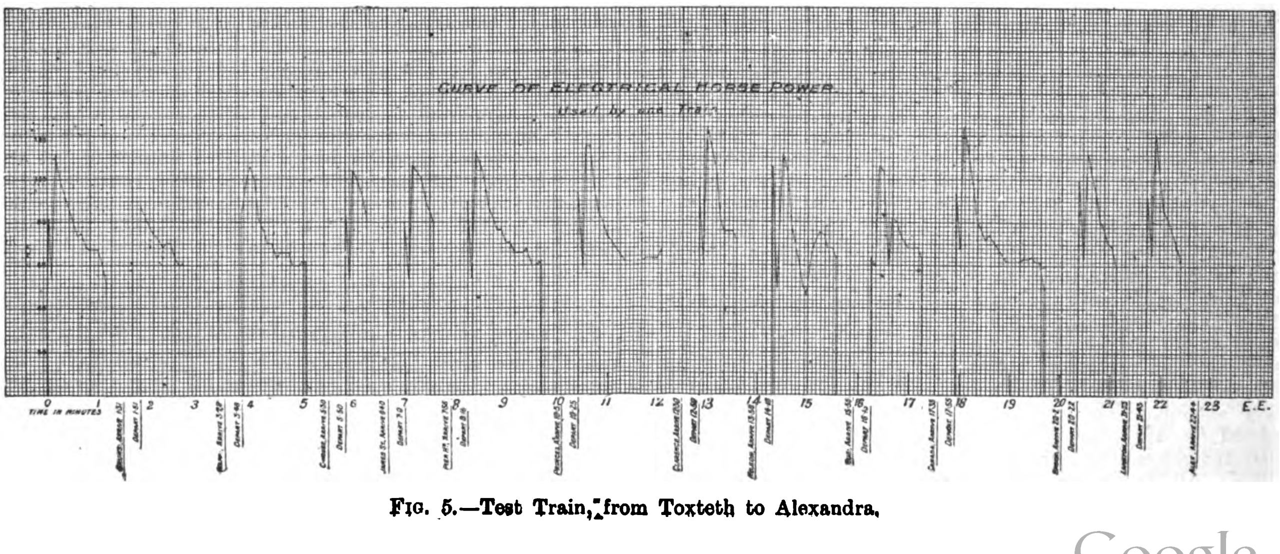


Fig. 5.—Test Train, from Toxteth to Alexandra.

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APPENDIX.—Liverpool Overhead Railway.—Half-years ending June 30, 1896 and 1895.

—	Liverpool Overhead Railway.				City and South London Railway.			
	Dec., 1894.	June, 1895	Dec., 1895.	June, 1896.	Dec., 1894.	June, 1895.	Dec., 1895.	June, 1896.
Value per passenger	1·67d.	1·92d.	1·97d.	1 96d.	1·66d.	1·73d.	1·71d.	1·72d.
Expenditure to revenue	66·84 %	66·43 %	59·97 %	63·05 %	60·87 %	61·55 %	59·62 %	60·22 %
Loco. ,, ,, gross expenditure	24·78 ,,	24 26 ,,	26·05 ,,	22 51 ,,	39·24 ,,	37·95 ,,	38·98 ,,	36·60 ,,
,, ,, ,, ,, revenue	16 56 ,,	16·12 ,,	15·62 ,,	14·19 ,,	23·88 ,,	23·36 ,,	23·24 ,,	21·86 ,,
Traffic ,, ,, ,, expenditure	38·88 ,,	37·54 ,,	35·33 ,,	36·05 ,,	38·70 ,,	39·13 ,,	38·69 ,,	38·91 ,,
,, ,, ,, ,, revenue	25 99 ,,	24·94 ,,	21·19 ,,	22·73 ,,	23·56 ,,	24·09 ,,	23 07 ,,	23·43 ,,
Expenditure per train mile	13·10d.	14·38d.	14·11d.	15·10d.	15·36d.	16 07d.	15·45d.	15·96d.
Revenue ,, ,, ,,	19 59d.	21·65d.	23·53d.	23·95d.	25 24d.	26·11d.	25 92d.	26·30d.
Loco. expenditure ,,	3·25d.	3·49d.	3·68d.	3·40d.	6·03d.	6 10d.	6·02d.	5·75d.
Number of passengers conveyed	3,641,379	3 460,060	3,780,375	3,739,575	3,275,649	3,113,199	3,172,438	3,192,672
Train mileage	314·472	311·346	321·417	313·010	230 604	224 259	227·350	225·554
Number of stations	16	16	16	16	6	6	6	6
Percentage of train punctuality	95 %	96·8 %	98 4 %	98·3 %	—	—	—	—

APPENDIX.—Liverpool Overhead Railway—Dissection of Cost per Train Mile.—Train mileage, 313,010; kilowatts generated (exclusive of battery charging), 1,343,129.

Half-year ending June 30, 1896.	Lbs. per train mile.	Lbs. per kilo-watt.	Pence per train mile.	Pence per kilo-watt.
Generating station – Coal	18·24	4·253	·491	·115
Ashes	—	—	·016	·003
Stores	—	—	·164	·039
Wages	—	—	·763	·176
Repairing department—Stores	—	—	·425	·099
Wages	—	—	·321	·074
Drivers' department—Wages..	—	—	1·220	·287
			3·400	—

to meet the additional weight of trains. The follow table and Fig. 4 give particulars:

Weight of armature ex. wheels, lbs.	Weight magnets and attachments.	Draw-bar pull. With 120 amps.	Draw-bar pull. With 60 amps.	Speed with 50 amps.	Max. efficiency.
2,184	6,066	2,030	680	26 M.P.H.	86%

As this new rolling-stock will only be a small portion of that owned by the company, it will be necessary to increase the number of carriages in the present trains, but as the first motors were only designed for two carriages, experiments have been made with a train fitted with a new and very ingenious form of roller bearings designed by the Roller Bearing Company. It has been shown by the falling weight test that this train will start at a reduction of more than 80 per cent. in starting effort over a train fitted with ordinary bearings, and therefore the company will be able by slightly modifying their present motors and adopting roller bearings to increase the carrying capacity of all their trains by adding an additional carriage.

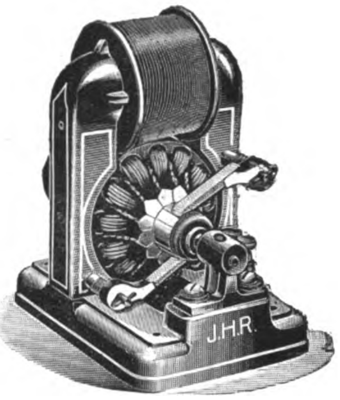
The engineers for the southern extension have been Sir Douglas Fox, M.I.C.E., and Mr. J. H. Greathead, M.I.C.E., and the author has acted as resident engineer, assisted by Mr. Norman and Mr. Fright, and the contractors have been Messrs. Pearson and Knowles for the viaduct portion, and Messrs. H. M. Nowell and C. Braddock for the tunnel portion.

The railway has now been working for over 3½ years, and it has proved that working on the zone system as regards fares and having only two classes is the best for railways of its character, the value per passenger being 1·97d., as against 1·75d. on the Metropolitan Railway in London, whose fares are very much higher than on this railway. The zone system allows an economy of about 25 per cent. on the staff, and as tickets are only used for first-class passengers there is considerable economy in printing.

The maintenance of the line is naturally very heavy, as there are alone over 80 acres of surface to be protected from corrosion, of which 20 acres are painted with an oxide paint and remainder with black varnish, and at the present it is being painted at the rate of once in two years. During this year experiments have been made with a pneumatic painting machine, which blows the paint on, the result being to reduce the cost from 2·25d. per square yard to 1·24d. per square yard, including all materials. The motors now run an average of 40,000 miles before requiring repairs, in which time they earn over £200, and can be rewound at a cost of £25. The company has at the north end of the line fully equipped workshops, where they carry out all their own repairs. In the appendix will be found a comparative statement of receipts and expenditure, and dissection of locomotive expenses, and Fig. 5 gives curve of electrical horse-power for one train. Further detail of the first portion than I have described to you will be found in the publication of the Institution of Civil Engineers, vol. 117, in papers read before the members by Sir Douglas Fox, vice-president, M.I.C.E., and Mr. Greathead, M.I.C.E., and also by Mr. Thos. Parker.

THE RIGG MOTOR.

The demand for small motors for household and factory use is increasing, and we are glad to note that English manufacturers are taking up their production on a large scale. The larger proportion in the prime cost of these motors is due to labour, and hence any simplifications of design tending to reduce the labour charges are most valuable. The subdivision of labour and interchangeability of parts, which can only be satisfactorily introduced when manufacturing in quantity, will enable foreign competition to be resisted. The Rigg motor, as illustrated herewith, shows a convenient type for small sizes.



The Rigg Motor.

The characteristics of this motor are as follows: The armatures are built up of charcoal-iron plates mounted on gunmetal spiders, and are of the iron-clad type; the shafts are of best cast steel, running in gunmetal bearings. The armatures being iron-clad the air-space is very small, and so the energy required for exciting the field is kept down to a small portion of the total power required, and the motor is consequently efficient. The field magnets are of special cast iron in the smaller and cast steel in the larger sizes, and mounted on a brass bed. The motors are well insulated, well made, and very efficient, and are wound for from 2 to 100 volts, either shunt, series, or compound. The whole of the component parts of the motor are simple in design, and the field-magnet construction requires little machine work, and there is no doubt but that the iron-clad type of armatures give great advantages in a small-sized motor.

Fatality on the Liverpool Overhead Railway.—Alex. Dallas, aged 61, who was formerly staff-sergeant of the Scottish Fusiliers and had served in the Crimea, was killed on Sunday afternoon by a train on the Liverpool Overhead Railway. It is supposed he was alighting after the train had started, for he was seen to fall between the footboard and the platform.

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THE OUTLOOK.—No. 2.

In our article last week we confined our remarks almost entirely to electric lighting. The Brush meeting, of course, gave us our text as it gives us one again to-day. Of course we are harping back upon an old hobby, one we have trotted forth on many occasions. Our views, however, on these questions, as on many others, have, unlike the prophetic ones of those who prophesy without good ground to go upon, turned out approximately correct. In the first place, then, we do not believe that any English company is going to largely extend its sphere of operations in the direction of electric tramways for some time to come. If the immediate business of any company is dependent upon tramway work, it will prove a broken reed. There is always, of course, the retort that directors and people behind the scenes know better than newspaper scribblers. Generally that may be so, specially it is altogether wrong; and we imagine our means of obtaining information is better than that of any individual firm, or, indeed, of half a dozen combined. It is true that a number of schemes for electric traction are floating about, and we think we could almost state into whose hands the work would fall if the financial *pourparlers* prove successful. A long time, however, is likely to pass before many of these schemes are ripe. This conclusion does not mean that we are despondent about the final success of electric traction, but that for many reasons its development in this country will not be rapid. It might be otherwise if any firm could guarantee self-contained cars worked electrically at somewhere about the cost of horse traction. Our remarks do not extend to foreign or colonial development. Here, however, we are brought face to face with Continental and American competition, both competitors very keen, both having more experience, and both very much alive to the openings where such traction is possible. Thus while our factories may obtain a few orders, an extensive demand is hardly to be expected at once. Let us not be mistaken; we are neither optimists nor pessimists, but prone to take things as they are rather than to take them as interested parties would like them to be.

There is a direction in which we imagine, with careful management, development should take place fairly rapidly, and if this should be the case, the larger factories ought to benefit to a considerable extent. The distribution of power is extending in England as most new ideas extend. A few of the more advanced have taken it up, and these have been followed till quite a number of factories employ motors for driving machinery. The latest indication of the progress of this class of work is to be found in the presidential address of Colonel H. F. Swan to the North-East Coast Institution of Engineers and Shipbuilders on Wednesday last. Colonel Swan, among other things, says:

"There is no question that electricity is destined to play a very important part in connection with shipbuilding in the future, both as regards portable appliances and also the general driving of the shop machines. It of course involves a certain amount of courage, not to speak of a large expenditure of

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capital, to abolish existing steam-engines, boilers, etc., and replace them entirely by electric power. Some establishments are therefore dealing with the matter tentatively, whilst at Hartlepool one of the chief yards has been laid out for electric driving entirely, thus abolishing several isolated boilers and steam-engines and dispensing with the necessary attendants, and, in addition, obtaining the facility of being able to use only such individual machines as are actually required from time to time instead of having, as at present, all machines going, whether wanted or not, which with the loss of power by transmission through long lines of main shafting, counter-shafting, pulleys, belts, etc., involves a total loss of the power transmitted varying from 30 per cent. to as much as 70 per cent."

We believe it is absolutely correct to say that wherever electricity has been properly tried for such factory work it has been proved better and more economical in every way. Broadly speaking, this economy was foreseen, and has been referred to many times by us. The concentration of engines and boilers, and the greater economy thereby both in fuel and wages; the getting rid of the constant drain upon the power developed from rotating shafting, pulleys, etc.; the using in the machine just what power is wanted for the exact time it is wanted; the greater cleanliness, and so on, were bound to lead to economy. More and more factories are adopting the method, and more will follow, so that business ought to be brisk in this direction. One feature that tells against our factories is their inability to hold the trade in small motors. These in most cases are obtained from the Continent or from America, a state of affairs worthy of attention. Lastly, for our purpose at the present moment, we would direct attention once more to the economics of central-station work. Here you have a mass of costly machinery standing idle most of its time, or moving merely to supply a few lamps. This machinery in many places ought to be earning income. Power is required by small users as well as large. If they could, the former would have it from the central station. Sometimes a separate set of power mains would be necessary, but the return would be enormous compared with this initial cost and annual maintenance. The stumbling block is that designers in England have not catered for the possibilities of power work. They have in places stuck in alternate-current plants where direct-current would be better. They have, further, stuck to single-phase work rather than diphase or triphase, although for motor work the single-phase is probably the most difficult wherewith to obtain satisfactory results. Again, we must qualify ourselves; there are many stations where light, and light only, has to be considered. Our contention is that in other stations, where power distribution ought ultimately to be the more important and the largest earning factor, it has not been considered at all. We have been more than once told that English people would be frightened at the larger initial expenditure required, and to act on these views would retard rather than hasten the demand for electrical apparatus.

REVIEWS.

The Principles of the Transformer. By FREDERICK BEDELL, Ph.D. The Macmillan Company.

This volume is an amplification of a work commenced by Dr. Crehore and the author in 1891. The joint authorship resulted in a series of articles published in the *Electrical World* on the theory of the transformer. In the present volume much new matter has been added, and the special treatment of several problems is decidedly new. The author has not confined himself to the mathematical and graphical treatment of the subject, as seems to be the case when the book is first turned over, but has incorporated many useful hints on the practical side of the subject. The first chapter deals with the different transformer systems of distribution. Diagrams of how to make and how not to make the necessary connections outside the transformers are given, and several general conclusions are drawn. Thus the author is not a blind advocate of alternate-current work, but considers that "the direct current may be used to advantage in districts, all parts of which are within about half a mile of the central station," but that "beyond that distance it can rarely be operated economically." He also refers to the fact that although in thickly-populated districts the direct current can be commercially successful, over larger areas it may be that the alternate-current system would give additional profit. The diagrams of connections given for placing transformers in parallel on low-tension mains or to supply on to a three-wire network are worthy of attention, as many interruptions in a town supply have resulted from faults in this direction. In the next chapter the reader is primed with the symbols and conventions used throughout the book, and we are pleased to see that as a rule the symbols agree with those used in this country. The letter N is said to refer to magnetising force, but we fancy this must be a misprint rather than an innovation, as H seems to be invariably used throughout the following pages. J is used for impedance, and I for current, which will be rather strange to the English reader at first. The convention as regards the various values of the different harmonic variants is as follows: The plain capital denotes the maximum value, the same capital with a bar over it denotes the virtual value—*i.e.*, the square root of the mean square of the instantaneous value—and the small letter stands for the instantaneous value. These conventions and several others save a large amount of space and writing, and are worth acquiring. The third chapter starts the theoretical treatment of the transformer by dealing with the magnetic circuit, and a fair knowledge of mathematics is required to read the subsequent chapters. To anyone taking up the subject with leisure, the mathematical and also the graphical treatment will be most interesting. We confess our preference for the graphics, and the fact that most of the diagrams are constructed to agree with the characteristic of real transformers adds to their value. On the question of the shape of the current curve the author assumes that all shapes can without appreciable error be treated as sine curves. This does not assume that the current and E.M.F. curves actually are harmonic, but that an harmonic current and harmonic E.M.F. can be found to give similar effects. This is not rigorously correct, but it simplifies the treatment greatly. Special cases can be investigated by the aid of Fourier's series of sine functions if absolute accuracy is required. The author in the chapters on the alternate current and on the simple transformer diagram leads the student gradually up to the subject as treated graphically before he really commences the analytical theory. This enables a physical conception of the phenomena to be obtained. The various complicating secondary effects—such as the action of magnetic leakage and of condensers in either the primary and secondary circuit—are treated in the following chapters, and in all cases polar diagrams are found to be capable of solving the problems. In the fifteenth chapter the more practical part of the subject is again commenced, which will repay careful reading. The history of the transformer is dismissed in a few pages in favour of the principles of design. The following extract will show how fully the

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author is in accord with the requirements of the present time: "In the design of any apparatus the aim of the designer should be to produce the desired result with the smallest yearly expense. The yearly expense includes not only maintenance, interest, and attendance, but also the cost of power wasted in the apparatus, a just allowance for repair, and also for depreciation and final replacement. The ideal design must be based upon a consideration of each of these items of yearly expense as affected by the particular conditions under which the apparatus is to be operated; the best design for one set of conditions may not, and probably will not, be the best for other conditions." The author frankly acknowledges that a complete analytical treatment for designing transformers commercially is impossible, and that trial and error methods must be adopted in getting out new types. He then proceeds to discuss the proportions of cores and winding likely to give the best results, and by extreme cases shows what is to be avoided. The subdivision of coils and the relative position of primary and secondary winding to prevent magnetic leakage is also referred to in general terms. We are surprised, however, to see a statement that oil in the case improves the coil insulation. That the coils so immersed are less likely to break down from sparking we know, but as a general rule the insulation resistance is lowered. A few practical designs are given, and then the author makes some computations as to the all-day efficiency of different transformers under certain assumed loads. The methods of obtaining experimental diagrams as described in the following chapter are interesting, and the standard method of testing transformers forms the subject of another chapter. On the whole, the book tends to advance the abstract rather than the practical treatment of the subject, but it is a valuable addition to the literature on transformers.

ON THE MULTIPLICITY OF BRUSHES IN LARGE GENERATORS.*

BY WILLIAM BAXTER, JUN.

When multipolar generators first came into use there was quite a difference of opinion as to the proper number of brushes. German builders adopted the plan of making the number equal to the number of poles, but the English electricians maintained that this complication was undesirable and inexcusable, inasmuch as it could be avoided by the simple process of cross-connecting the commutator. American engineers, as a rule, were in favour of single brushes in the early days, but they soon changed to the multiple system; and at the present time it is doubtful if a manufacturer can be found who does not follow the latter construction.

The reason for this change from simplicity to complication is to be found in the fact that carbon brushes came into use at about the time when the multipolar machines were being introduced; and as these brushes are of a much lower carrying capacity than copper, the number in parallel, or in other words their cross-section, must be increased. This, as is evident, can be done in two ways, one of which is to widen the face of the commutator so as to place a greater number in a row; and the other is by placing brush-holders at all the equipotential points and connecting the alternate ones in parallel. If the latter plan is adopted the face of the commutator can remain of the normal width, and this fact is, in all probability, the chief cause for its adoption, it being believed, no doubt, that the cost of construction would thereby be reduced and a more symmetrical design obtained. It is by no means certain that the multiplicity of brushes reduces the cost of construction or that it renders the design more symmetrical; but even if it did its adoption could not be deemed advisable for these reasons alone. There are two things to be considered in all such cases; the first and most important one is the effect upon the operation of the machine, and the second the cost of construction.

A very little reflection will show that the two-brush machine will prove the most satisfactory to the user, and will be subject to less deterioration, owing to the fact that it will be better taken care of. If there are but two brushes, they can be located at any point on the periphery of the commutator, where they will be most accessible, and this fact of itself will ensure their receiving better attention. If multiple brushes are used, this may not be the case; in fact, it is almost sure not to be. The brushes on the sides and on top of the commutator will receive proper care, but those underneath will not, for even the most faithful attendant cannot be expected to watch as closely these inaccessible parts, and it is very probable that the owner himself would neglect them if he had to take care of the machine. Many men maintain that such objections amount to very little, that the attendants are paid for their services, and if they do not perform their duties faithfully they can be discharged and better men obtained; but the fact is, as everyone who has had experience in such matters knows, that it is difficult, if not impossible, to find men who will give just as much attention to inaccessible parts as they will to those that can be reached without inconvenience or danger. Another objection to the use of multiple brushes is the difficulty involved in adjusting them to the non-sparking points. This is by no means an unimportant matter, for upon it depends the life of the commutator to a very great extent. Unskilled men very often find it difficult to set a single pair of brushes so that they will not spark; such being the case, what can be expected when multiple brushes are used? If all the men who take charge of electrical machines were competent, the difficulty of adjusting multiple brushes would not be very much of an objection, but the number of incompetent men is very great and is constantly on the increase. There was a time when those who knew nothing about electrical machinery would not attempt to take care of it for fear of being killed by a shock, but any number have now found out that there is no such danger with incandescent lighting generators, and the result is that there are engine attendants everywhere who claim to be expert in the care of generators simply because they have had charge of one for a few months. The fact that the proper adjustment of multiple brushes is beyond the capacity of the majority of the men who are in charge of machines of that type can be verified by an actual inspection of isolated plants. Two-pole generators that run sparkless can be found everywhere, but a sparkless running multiple brush machine is the exception, and this is true even in plants of several hundred kilowatts capacity.

If these points are well taken, then it is evident that machines with a single pair of brushes are the most desirable from the standpoint of the user. They will be kept in better adjustment, not only because it requires less skill to do so, but also because the parts are more accessible and therefore can be given the proper attention without inconvenience.

The sparking of multiple brushes is not always the fault of the attendant. In many cases it is due to the fact that the various parts of the machine are not in accordance with each other, and therefore the non-sparking points either shift backward and forward as the armature rotates, or else are never in line with the brushes. If the brushes are placed at equal angles around the commutator, they may and they may not rest on the non-sparking points. If the commutator segments and the armature sections are equally spaced, and the magnetic circuits are of equal strength, and the fields symmetrical, the equipotential points and the position of the brushes will agree, but under any other condition they will not. It is difficult to obtain exact agreement of all these points, therefore it is difficult to obtain a non-sparking condition with multiple brushes. The result is accomplished by the best manufacturers, but only by the exercise of the greatest skill in the design and the greatest accuracy of workmanship in the construction.

With two brushes all these difficulties are considerably reduced, and the same amount of skill and accuracy of workmanship will produce better results, or, more properly speaking, such a machine of equally good design and construction can be adjusted to run with less sparking. The reason for this is that if there are as many brushes as there are poles, each one must rest on a neutral point to avoid sparking. If the fields are not symmetrical and of equal strength, the neutral points will not be equally spaced around

* From the *Electrical World*, New York.

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the commutator, and therefore it will be impossible to have all the brushes on the line. If only two brushes are used this difficulty will not be encountered; if the armature is wound with the equipotential sections in series, the irregularities in the induction of the several magnetic circuits will, to a very great extent, counteract each other, and as a result the difference between the arc separating the brushes and that between the neutral points on the commutator, with which they come in contact, will be so small as to produce little or no sparking tendency. If the armature is connected in parallel, the inequalities of induction in the several magnetic circuits may shift the position of the neutral points on the commutator, but as only two of these are in contact with the brushes, two can be adjusted so as to nearly agree with each other sufficiently well to obviate practically all sparking.

If the series connection of the armature could be used in every case perhaps the majority of engineers would be in favour of the two-brush system, as then the cross-connection of the commutator would not be necessary. It is very generally believed that a cross-connected commutator is not as reliable as one not so made, and also that it is expensive to manufacture. These notions, however, are not correct; there are simple ways of cross-connecting that are perfectly reliable and not at all expensive—in fact, as far as cost goes, the saving of the brush-holders, and ring for supporting them, would more than pay for the additional expense placed on the commutator by the cross-connecting thereof.

In the early days of multipolar generators there was a valid reason for not using two brushes, which was that as carbon brushes were used the surface of the commutator would have to be widened. Since that time, however, woven wire brushes have come into use, and have been found to be equal, if not superior, to the carbon. The carrying capacity of these is so high, and the resistance of contact so low, that, with them, extra width of commutator would not be necessary.

The writer has many times tried to find out why everyone adheres to the multiple brushes, but has thus far failed. In almost every case the reason given is that the matter has been thoroughly investigated and the latter arrangement found to be the best. This is a very indefinite although easy way of disposing of the case, but it proves nothing. A great many men may have come to the above conclusion after a thorough investigation of the matter, but others, and perhaps a greater number, after a similar investigation have come to the opposite conclusion. To the writer it looks very much as if this were another verification of the old saying that men's minds run in grooves. There are very few leaders, and most everyone follows in the footsteps of those who are successful. As the large concerns have adopted the multipolar construction, the smaller ones fall into line and do the same thing, because they are afraid to strike out on an independent track. Perhaps some day a concern of more than ordinary courage will depart from the beaten path and place on the market two-brush machines. If such a thing should come to pass, we would be able to find out in a practical way which system is the best. In the opinion of the writer the two brushes would come out victorious.

SCREW GAUGE.

Report of the Committee, consisting of Mr. W. H. PREECE (*Chairman*), Mr. CONRAD W. COOKE (*Secretary*), Lord KELVIN, Sir F. J. BRAMWELL, Sir H. TRUEMAN WOOD, Major-General WEBBER, Mr. R. E. CROMPTON, Mr. A. STROH, Mr. A. LE NEVE FOSTER, Mr. C. J. HEWITT, Mr. G. K. B. ELPHINSTONE, Mr. T. BUCKNEY, Colonel WATKIN, Mr. E. RIGG, *and* Mr. W. A. PRICE, *appointed by the British Association to consider means by which Practical Effect can be given to the Introduction of the Screw Gauge proposed by the Association in* 1884. *(Drawn up by the Chairman.)*

I. THE PAST.

A uniform system of screw threads was first proposed by the late Sir Joseph Whitworth in 1842, and his thread, a compromise of the numerous threads then in use, has become of almost universal use for all large screws—that is, screws of over ¼in. in diameter—in the United Kingdom. Mr. William Sellers, in 1864, introduced another thread in the United States of America, which has come into very general use in that country, and this thread has recently been accepted by the French. In 1881 the British Association formed a committee to determine a gauge for the manufacture of the various small screws used in electrical apparatus, clockwork, and for other analogous purposes, and after three years of unremitting labour this committee, in 1884, recommended a screw gauge which has come into very general use in this country. It was based on the metrical system, and, with one slight modification, on the system adopted in 1880 by the Swiss watchmakers. The series of screws recommended is given in Table I.

TABLE I.—British Association Screw Gauge.

Number.	Dimensions in millimetres.		Dimensions in thousandths of an inch.		Threads per inch.
	Diameter.	Pitch.	Diameter.	Pitch.	
I	II.	III	IV.	V.	VI.
0	6·0	1·00	236	39·4	25·4
1	5·3	0·90	208	35 4	28·2
2	4·7	0·81	184 ?	31·9	31·4
3	4 1	0·73	162 ?	28·7	34·8
4	3·64	0·66	142	26·0	38·5
5	3·2	0·59	126	23·2	43·0
6	2·8	0·53	110	20·9	47·9
7	2 5	0·48	98	18·9	52 9
8	2·2	0·43	87	16·9	59·1
9	1·9	0 39	75	15·4	65·1
10	1·7	0·35	67	13·8	72·6
11	1 5	0·31	59	12·2	81 9
12	1·3	0·28	51	11·0	90·7
13	1·2	0·25	47	9·8	101 0
14	1 0	0·23	39	9·1	110 0
15	0·90	0·21	35	8 3	121·0
16	0·79	0 19	31	7 5	134 0
17	0·70	0·17	28 ?	6·7	149·0
18	0 62	0·15	24	5·9	169·0
19	0·54	0·14	21	5·5	181 0
20	? 0 47	0 12	19	4·7	212·0
21	0 42	0·11	17	4 3	231·0
29	0·37	0·098	15	3 9	259·0
23	0·33	0·089	13	3·5	285·0
24	0·29	0·080	11	? 3·152	317 0
25	0·25	0·072	10	2·8	353·0

The form of thread adopted was triangular, the sides forming an angle of 47½deg., with the top and bottom rounded off to two-elevenths of the pitch. The diameter, D, is related to the pitch, P, by the formula $D = 6\,P^{\frac{6}{5}}$, all measurements being in millimetres, and P having successively the values: 1 (or $0{\cdot}9^0$) millimetre; $0{\cdot}9^1$ millimetre; $0{\cdot}9^2$ millimetre; $0{\cdot}9^3$ millimetre; . . . $0{\cdot}9^n$ millimetre. The index n thus becomes a convenient number designating the screw.

The reasons supporting these recommendations were fully given in the report submitted by the committee at the Montreal meeting of 1884. Experience has justified the adoption of this gauge, which is almost universally used by the electrical trade, and is very considerably employed by the clock and instrument makers in the United Kingdom. It is not proposed to modify it, but there has been great difficulty in obtaining accurate gauges. No official system has yet been adopted by which manufacturers can compare their gauges with the standards, nor has a home been selected to deposit authorised standards for easy reference. British Association screws bought to-day from any screw manufacturer are not necessarily of the same dimensions as those supplied by the same maker a month ago. Screws supplied by different makers vary considerably from each other. Measuring gauges now existing, both male and female, differ largely from one another, and do not give correctly the true form of thread specified in the original report. The essential element of the value of screws made to a standard gauge—their interchangeability—has thus never been fully realised.

The British Association, having had their attention called to these anomalies at their last meeting (Ipswich, 1895), appointed a committee to consider the subject, which has now the pleasure to submit its first report.

II. THE PRESENT.

The committee was formed "to consider means by which better practical effect can be given to the introduction of the screw gauge proposed by the association in 1884." It has held many meetings. It has added Colonel Watkin, C.B., R.A., Mr. E. Rigg, and Mr. W. A. Price to its number. It has received great assistance from the Pratt and Whitney Company, of Hartford (Connecticut, United States of America), who supplied each member of the committee with a copy of their book on "Standards of Length and their Practical Application." It was unfortunately deprived of the services of Mr. Hewitt, who was seized with a very severe illness after the first meeting,

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but it received from him his paper "On the Manufacture of Standard Screws for Machine-made Watches," read before the Institution of Mechanical Engineers in October, 1894, a paper which has been of great service. Mr. Griffith, representing the council, attended regularly, and took advantage of his presence in the United States of America to visit the Pratt and Whitney works. Evidence was taken by the committee from large users of the screws. Mr. Willmot, of the Post Office Factory, stated that the Post Office had used some tens of millions of screws made to the British Association gauge, and he had never received a single complaint. Various apparatus for measuring screws and different methods of testing their accuracy were carefully considered and discussed. The committee came to the conclusion that it was necessary to consider the subject from the three points of view of the Standards Office, the works manager, and the workman.

1. *The Standards Office.*

This must include not only the custody of recognised and authenticated standards, but also a scientific mode of measuring the dimensions of commercial gauges and screws themselves, and of comparing their accuracy with the authorised standards. The peculiarity of the British Association gauge is this, that material standards are not imperatively necessary. The table of dimensions given (see Table I.), together with the formula, enables any draughtsman to reproduce the form and pitch to any desired scale on paper. Colonel Watkin has shown to the committee how to throw side by side for purposes of very accurate comparison a photographic image of (*a*) the screw to be examined; (*b*) the standard with which it is to be compared; (*c*) a scale which may be divided to 1-10,000in., the images of these three objects being so close to one another that a comparison to a very high degree of accuracy can be made. The appendix to this report contains a description of Colonel Watkin's method.

Mr. Price submitted to the committee a microscopical method of measuring screws. This is described in the appendix. The screw to be measured is attached to the stage of the microscope, the traversing slide of which is provided with a vernier and scale, while a vertical cross-hair in the eye-piece forms the index of the instrument. When the microscope has been adjusted for clear focus the screw is traversed across the field until the cross-hair intersects the thread of the screw at the desired point. The traversing screw of the slide is then turned until the corresponding point of the next thread is intersected by the cross-hair, and the reading of the vernier on the scale gives the measurement of the pitch with great accuracy. Mr. Buckney showed also how the angle of the thread could be accurately verified by this method by having suitable h airs.

2. *The Works Manager.*

The committee, after considering various methods, came to the conclusion that male gauges for ordinary workshop use were best tested as regards pitch and form of thread by a template or "comb" for each number, the accuracy of which has been verified by the photographic method. The screw to be tested is placed against the teeth of the comb, and the correctness of its fit verified by the eye against a light background. The external dimensions of the screw can be obtained by any good micrometer gauge, and the internal diameter or core by a gauge such as that which is described in the appendix by Mr. Stroh. The committee have failed to discover any very reliable method of testing to any degree of accuracy a female standard gauge. No clearance was allowed in the original definition of the system between the male and female standards. Hence a mathematically accurate male gauge cannot be screwed into a mathematically accurate female gauge. But by allowing a certain margin—a maximum and minimum diameter—an internal compatibility of dimensions is allowed in the workshop gauges, which is of a sound, practical character. The female screw must always be a little larger than the standard male gauge, but this must never exceed what is known as a "good fit." A working margin is given in Appendix III., by a table, prepared by Mr. Le Neve Foster. Mr. Price, on behalf of the committee, has made a series of measurements of certain sizes of British Association screws which show the limits which they are obtained in practice. The table (Appendix IV.) indicates that the variation from the full diameter, which must be allowed for necessary inequalities in manufacture, is not a function of the diameter, but is rather in the nature of a constant quantity. This quantity appears to be approximately one mil below the full diameter for all brass screws of sizes Nos. 0 to 11, and 1·3 mils for all iron and steel screws of the same sizes.

3. *The Workman.*

The measuring gauge, available to the workman as well as to the foreman, is one that need not possess the mathematical accuracy of the standard gauges, but nevertheless it must not be allowed to deteriorate or to maintain false belief in its accuracy. Those that are subject to pressure and friction must necessarily wear, become distorted, and in time inaccurate. Hence, the committee were anxious to obtain a mode of comparison which would be free from this source of error. The most important measurement, whose accuracy should be easily verified by the workman, is that of the pitch, and this is easily effected with the "half-nut gauge" described in Appendix II. The committee are pleased to find that the result of their enquiry and discussion enables them to recommend for general use means of comparison which do not involve the wear and deterioration of the gauges. Deformation is confined to the taps and screw-plates, and as frequent verification of the manufactured screw is desirable, continued accuracy is ensured. With the introduction of simple methods of comparison and measurement errors in the screws issued, and want of interchangeability are rendered improbable in a well-regulated shop, and unnecessary in any place. There remains now to determine a place where material standard gauges are available for immediate comparison and where the photographic and microscopic methods can be readily applied to verify gauges and to obtain a record of those submitted for examination. This means work to be done, expenses to be incurred, and fees to be paid, as is now done at the Kew Observatory for chronometers, thermometers, etc.

III. The Future.

The opinions formed by the committee after full and exhaustive discussions for furthering the objects to be attained, may be summarised as follows: (*a*) This committee recommend the construction and housing of the comb form of gauges or templates of the British Association screw thread, by comparison with which master gauges or templates may be exactly and conveniently verified. (*b*) That as no exact system of testing female threads has yet been devised, the committee restrict themselves to recommending means for keeping male threads to gauge, and this they consider will be sufficient for the purpose of securing practical uniformity in female screws. (*c*) Male threads can best be measured by the comb, combined with suitably-arranged tests to give the correct diameters. (*d*) That for purposes of verification or standardisation the gauges to be deposited for reference should consist of a complete set of these comb-pieces and a complete corresponding set of male screws, so that new combs can be compared with those deposited, or male screws can be compared with the standard combs with great accuracy by the photographic or the microscopic method, and that these two methods may be conveniently used to check and corroborate one another. (*e*) That in order to obtain interchangeability of these male screws for practical workshop use it is sufficient that they should satisfy the following tests: (1) There should be no appreciable difference in the fit of the screw with a standard comb having not less than 12 teeth. (2) The diameter of the core must not exceed that laid down by the British Association specification. (3) The diameter of the screw measured over the thread must not exceed that laid down by the British Association specification. (4) The diameter of the screw measured over the thread must not fall short of that laid down by the British Association specification by more than a certain amount, which amount depends on the class of work and purpose to which the screw is to be applied. The amount referred to in (4) must be settled by the persons in control of the work for which the screws are to be used. (*f*) They recommend for general use in the workshop the half-nut gauge, as described in Appendix II., combined with inside and outside diameter gauges.

The committee, in printing the two tables, for which they have to thank Mr. Le Neve Foster and Mr. Price, do not take the responsibility of recommending any limits, but publish the information as an indication of the limits of accuracy to which these screws may be expected to be produced in practice. If the recommendations of the committee be approved of, they further recommend that the committee should be reappointed for the purpose of obtaining and verifying standard combs and male screws, and determining the future home of the gauges.

APPENDIX I.

Enlarged Shadow Photographs of Screws. By Colonel Watkin, C.B., R.A., etc.

The objects aimed at in producing enlarged photographs of screws are: (*a*) To provide a means of verifying the accuracy of the shape of a thread; (*b*) to provide a means of accurately gauging the dimensions of screw threads; (*c*) to provide a record or certificate of a screw in a similar manner to the certificate of accuracy given by Kew Observatory.

As in this process a standard scale is photographed at the same time as the screw, a direct reading to any desired accuracy can be obtained. There seems to be hardly any limit to the amount of enlargement, as the difficulties inherent to the enlargement of an ordinary negative do not apply to this process.

The question arises, does the shadow photograph give accuracy as regards (1) dimensions, (2) shape of thread? To test (1) a No. 2 British Association thread was enlarged 37·18 times. The linear dimensions could in this photo be measured to at least 1-5,000in. The diameter, pitch, and angle of thread of this particular screw were gauged by a member of the committee, and found to be:

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By an Elliott gauge .... 0·1818 } diameter.
By a Brown and Sharp gauge 0·1820 }
0·03184 pitch.
54°·30′ angle of thread.

The photo gave the following:

0·1818 diameter.
0·03181 pitch.
54°·30′ angle of thread.

Fig. 1 shows a reduced copy of an actual photograph and scale. As regards (2) there has been considerable discussion as to

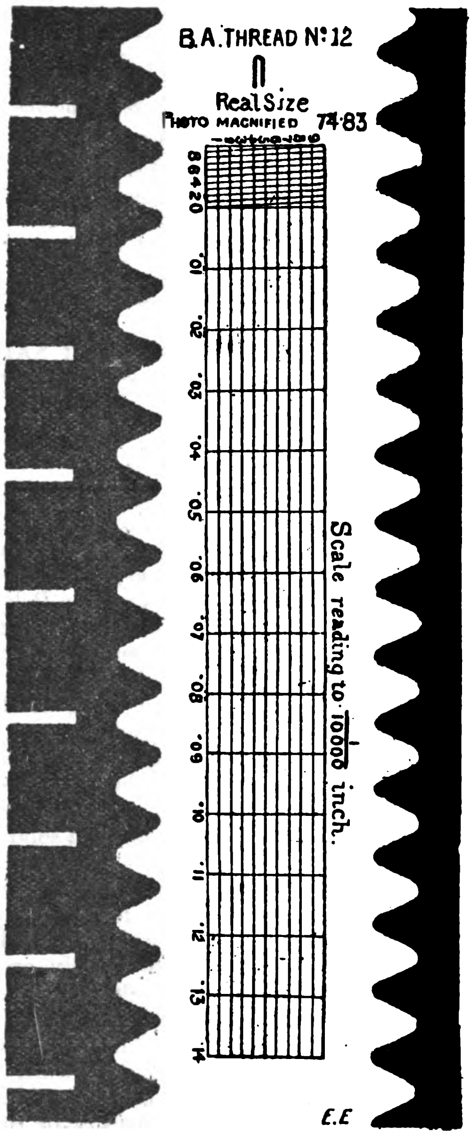

FIG. 1.

method, a mathematical consideration worked out by Mr. Price seems to show that a slight correction of about ⅓deg. in the total angle of the screw thread would have to be made. I think, as regards the second method, no correction is required. In any case, the correction is so small that for practical purposes it might be neglected, as on a No. 2 British Association thread it only represents about 1-7,000in., and proportionately less on the smaller sizes.

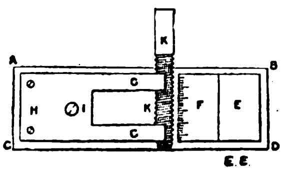

FIG. 2.

However, to determine practically whether this was the case, I suggested filing away a part of the screw to be photographed to make it a comb. There could be no doubt that the photo of such a comb would give the true shape of the thread. Mr. Stroh kindly supplied such a screw. From the photos it would appear that there is no practical difference in the shape, and that therefore the photograph of a complete screw gives a true record of the shape as well as the dimensions. The following gives the whether the shadow photograph gave the true shape of the thread. There are two methods of obtaining a photograph of a screw thread—one in which the axis of the screw is at right angles to the beam of light; the other in which the axis of the screw is inclined at an angle which differs from the right angle by the angle of the pitch of the screw. As regards the first detail of the method employed in photographing the screws: On a plate, A, B, C, D (Fig. 2), is a block, E, to which is secured a glass scale, F, which has been carefully etched with lines 1-50in. apart. A piece of spring brass, H G, serves to hold the screw, K K, to be photographed, with its axis parallel to the plate A, B, C, D. The distance of the screw from the plate can be adjusted by means of the screw, I, so that when

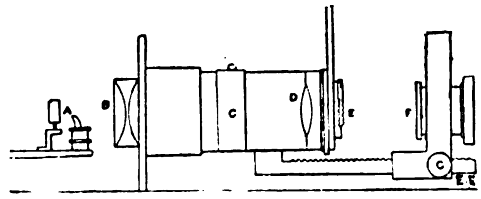

FIG. 3.

the scale is sharply focussed on the screen the shadow of the screw may also be brought into focus. The frame, A, B, C, D (Fig. 2), is adjusted in the same position as an ordinary microscopic slide in a magic-lantern arranged for microscopic work, only I found it desirable to employ a photographic lens of modern design instead of the usual objective. The arrangement is shown in the accompanying diagram (Fig. 3), where A represents the limelight, B the ordinary condenser, C alum-trough to stop the heat rays, D small condensing lens, E screw, in its frame as described in Fig. 2, F photographic lens, G milled-head screw for focussing the lens, F.

APPENDIX II.

Gauges for Verifying the Accuracy of Screws (for Workshop use only). BY A. STROH.

In the gauge represented in Fig. 4 the hole, *a*, is for the external diameter. It should be of exactly the diameter given in the table of sizes for British Association screws. A screw should pass into this hole freely, but without much shake. The hole *b* is the minimum gauge, and the screw should *not* pass into this hole. The difference of diameter between the holes *a* and *b* has not yet been determined by the committee; in the present case it is ·0015in.; *c* is a threaded hole or female gauge in which a screw should just turn freely. The hole *d* is for the diameter of the core, but as it is impossible, without turning down some of the threads of a screw, to pass the core of it into this hole, the gauge, *e*, is provided for gauging the core, or, in other words, the depth of the thread. It consists of a fork, the inner edges of which are shaped so as to enter between the threads of a screw. The correctness of the pitch of a screw is ascertained by placing it in the comb, *f*, and against the back-rest, *g*, and by holding the gauge against the light or a white paper.

It has been found by practice that there is considerable difficulty in making these combs with any degree of accuracy, and also that it would be almost impossible to carry out the above form of gauge for the smaller sizes. It is therefore

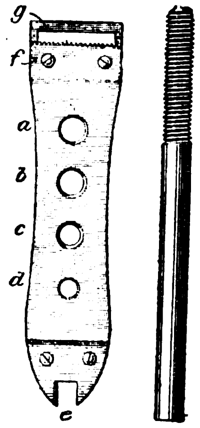

FIG. 4.

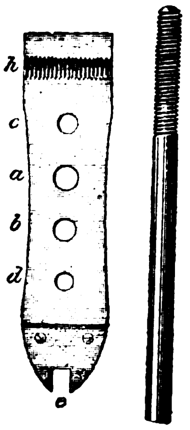

FIG. 5.

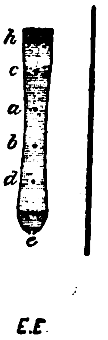

FIG. 6.

suggested that the gauge represented in Fig. 5 has certain advantages over the comb-gauge. With this the half-nut, *h*, is employed for verifying the pitch of screws, instead of the comb. The half-nut can be carried out with greater certainty and ease, and is therefore less costly, and there is no difficulty in making it for the smaller sizes, as shown in Fig. 6. Gauges on the principle of Figs. 5 and 6 have also the advantage of being more compact and stronger for workshop use.

The process of making the half-nut gauge is the following: Two have to be made at one time. When the two steel bars

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intended for the gauges are filed to shape they are placed together, as shown in sketch (*a* and *b*); a temporary rivet or bolt is put through the hole, *c*, and the ends intended to receive the half-nut device are clamped together as shown. A hole of the diameter of the core is then drilled across the two bars at *d*, so that each bar receives one half of it. The clamp is then unscrewed, the bars are slightly separated, the tap is inserted between them, and the clamp screw tightened again gently. Of course now the two steel bars cannot meet, being prevented by the insertion of the tap. But the smooth end of the tap is

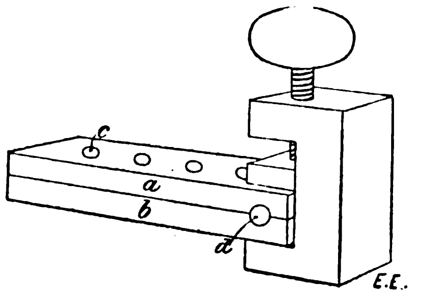

FIG. 7.

now fixed in a chuck on a lathe, and is rotated forwards and backwards, while the clamp screw is tightened from time to time. This is carried on till the threads forming the half-nuts are complete. It is only necessary towards the end of the operation to separate the bars once or twice for the purpose of removing the bur which is raised by the operation.

APPENDIX III.

TABLE II.—Working Dimensions in Millimetres and Thousandths of an Inch.

No.	External diameter.		Diameter of core.		Difference of diameter	Pitch.		Working margin.	
	mm.	inches	mm.	inches	mm.	mm	Threads per inch.	mm.	mils.
0	6 0	·236	4·8	·189	1 2	1·0	25·4	·05	·002
1	5·3	·209	4 22	·166	1·08	·9	28·2	·05	002
2	4·7	·185	3·72	·147	·972	·81	31·4	·04	0016
3	4 1	·161	3·22	·127	·876	·73	34 8	·04	·0016
4	3·6	·142	2·8	·110	·792	·66	38·5	·04	·0016
5	3·2	·126	2 5	0984	·708	·59	43·0	·03	·0012
6	2·8	·110	2 16	·085	·636	·53	47·9	·03	·0012
7	2·5	·098	1 92	076	·575	·48	52·9	·03	0012
8	2 2	·087	1 68	066	·516	·43	59·1	·02	·0008
9	1·9	·075	1·43	·0565	·468	·39	65·1	·02	0008
10	1·7	·067	1·28	·0505	·420	·35	72·6	·02	0008

TABLE III.

No. 0 Brass	No. 0 Brass	No. 2 Brass	No. 2 Steel	No. 4 Brass	No. 4 Steel	No. 6 Brass	No. 6 Steel	No. 8 Brass	No. 8 Steel	No. 11 Brass
·2373	·2385	1852	·1852	·1424	·1438	·1110	·1111	·0865	·0860	·0595
·2372	2382	·1850	·1851	·1424	·1437	·1109	·1110	·0864	·0858	·0594
·2371	·2382	·1850	·1851	·1423	·1434	·1108	·1110	·0863	·0857	·0594
·2370	·2380	·1849	·1851	·1422	·1434	·1106	·1110	·0861	0857	0594
·2370	2380	·1849	·1850	·1421	·1433	·1106	·1110	·0860	·0857	·0593
·2370	·2380	1849	·1850	·1421	·1432	·1106	·1110	·0860	·0857	·0593
·2370	·2380	·1849	·1850	·1421	·1431	·1105	·1109	·0860	·0855	0593
·2370	·2379	·1849	·1849	·1421	·1431	·1105	·1109	·0860	·0855	·0593
·2369	2379	·1848	·1848	·1420	·1430	1104	·1109	·0859	0855	·0593
·2368	2379	·1848	·1848	1420	·1430	·1103	·1109	·0859	·0854	0593
·2368	·2378	·1848	·1848	·1420	·1430	·1103	·1109	·0859	0854	·0592
·2367	2378	·1848	·1847	·1420	·1429	1103	·1109	·0859	·0854	·0592
·2367	·2378	·1848	·1845	·1419	·1428	·1103	·1109	·0859	·0853	·0592
·2365	2378	·1848	·1844	·1419	·1428	·1103	·1109	·0859	0852	·0592
·2364	2377	1848	·1843	·1419	·1426	1103	·1108	·0858	·0852	·0591
·2364	·2377	·1847	·1842	·1418	·1425	·1103	·1108	·0857	·0852	·0591
·2363	2376	·1847	·1842	·1418	·1422	·1103	·1105	0856	0852	·0590
·2362	·2375	·1842	·1842	·1418	·1422	1103	·1102	0856	0851	·0590
·2362	·2369	·1842	·1841	1417	·1419	1102	·1102	0856	0850	·0589
·2362	—	·1845	·1841	1417	1421	·1102	·1101	0855	·0850	·0589
·2361	—	·1845	·1841	1417	·1420	—	·1101	—	0850	·0587
		·1845	·1832	·1416	·1412	mean	·1100	mean	·0849	·0586
mean	mean	·1843	·1830	·1416	·1412	—	—	—	—	—
·2368	·2379	·1843	·1825	·1415	·1410	·1104	·1099	·0859	·0849	·0581
			·1820		·1410	—	·1094	—	0848	·0580
			Omitting last four mean ·1846		·1409	—	·1090	—	·0848	—
		mean ·18475		mean ·14205	·1408		Omitting last 2 mean ·1108		mean 0853	Omitting last 2 mean ·0592
					·1408					
					·1408					
					mean Omitting last 8 ·1429					

Mr. Foster informed the committee that in the experience of his firm the limits given in Table II. were found to be convenient for all screws connecting ordinary pieces of mechanism.

APPENDIX IV.

Tests of British Association Screws by Hervé Diameters.

Of the measurements given in Table III. all, excepting the No. 8 steel and No. 11 brass screws, were made with a gauge of which the zero was out of adjustment. The measures to be reduced by ·0002 in the first nine columns. These measurements were made to ascertain within what limits a screw maker can work, not as chausson screws with their theoretical diameters. It seems that 1·2in. below the full diameter is all that is required for brass screws Nos. 0 to 11, and that the same is required for all sizes. It is clear that steel screws are more troublesome than brass, but the lot of No. 4 steel examined were probably not made with sufficient care. The margins are:

1·2	1·0	·9	1·1	·9	1·8	·8	1·2	1·0	1·2	·9
	(1·6)		(3·2)		(3·0)		(2·1)			(1·5)

The figures in brackets in each case include the screws, even those that are clearly too small to pass. The No. 11 brass screws were a lot that Hervé had been asked to make with especial care.

THE ACTION OF METALS AND THEIR SALTS ON THE ORDINARY AND RONTGEN RAYS: A CONTRAST.*

BY J. H. GLADSTONE, F.R.S., AND W. HIBBERT.

The authors, having worked at the action of metals and metallic salts on ordinary light, extended the investigation so as to compare that action with the corresponding transparencies or absorptions for Röntgen rays. The work was principally carried on in the laboratory of the Polytechnic, Regent-street, and photographs of the results were exhibited. The metals experimented on include some with which it is difficult to work, such as lithium, sodium, and potassium.

In regard to the rays of ordinary light, solid metals absorb them completely, and are therefore opaque. If, however, the metals combine with an electro-negative radicle, they lose their power of absorbing light, except a few which show the phenomena of selective absorption. Solutions of salts resemble the crystallised solid in their action on light.

With regard to Röntgen rays, on the contrary, metals exhibit every degree of opacity or transparency, from lithium, which is practically non-absorptive, to such metals as gold and platinum, which are practically opaque, as shown by Barrett and others. The salts of these metals are not transparent, but the metal in them seems to have the same effect on Röntgen rays as in the uncombined condition. This seems to be equally true when the salts are dissolved in water. The order of absorption follows that of atomic weight, not that of density or combining proportion. The absorption of the Röntgen rays by a salt in solution appears to be that of both its constituents added together, plus that of the solvent.

APPLIED ELECTRO-CHEMISTRY.†

BY JAMES SWINBURNE.

LECTURE III.

One of the great difficulties in the commercial use of aluminium and many of its alloys is that of soldering. The problem of soldering aluminium is like that of making motors for ordinary alternating currents. It is solved with a flourish of trumpets every week or two, but somehow commercial aluminium articles are found to be carefully designed not to need solder. One of the difficulties is to get a clean surface of metal exposed to the solder. The principle underlying the use of such fluxes as zinc chloride, rosin, or borax, is that they dissolve the oxide of the metal to be soldered, and of the solder, leaving two clean surfaces to run together. Now, there are few chemicals which will dissolve alumina which will not also vigorously attack the surface of aluminium. There are, however, a few substances available, but some of them need such a high temperature to enable them to dissolve

* Abstract of paper read before the British Association at Liverpool

† Cantor lectures delivered before the Society of Arts.

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the alumina that the metal is softened. This prevents such fluxes being used for rolled or stamped aluminium work, as once it is softened the metal loses much of its value. A soldered vessel, for instance, cannot be re-rolled to harden the metal again. One method of getting the solder to stick is to scratch the aluminium under the surface of the solder. There are also several kinds of solder in the market which take on aluminium. This is not enough, however. To make soldering efficient it should not only adher where carefully rubbed on, but should run easily and quickly into joints and crevices, as in sheet-tin, lead, or brass work.

Once the solder has been got to adhere the joint may be quite useless. It is quite easy, for instance, to solder two pieces of aluminium together, so that they will tear through the metal rather than through the solder. Similarly, a screw head may be soldered to sheet aluminium, and when torn off it will take a disc of aluminium with it rather than break the joints. Make these joints and examine them after a few months or even weeks and it will be a very different matter. The solder appears to separate completely from the aluminium, or at any rate it comes off with the slightest force. I believe this does not happen with all samples. It may be due to sodium in the metal, or it may be due to an alloy between the solder and the metal being able to decompose water and thus being corroded. It is possible, for instance, a trace of sodium may help an alloy of aluminium and tin to decompose water. It is a curious thing that a failed soldered joint frequently has the same smell as iron has when acted on by dilute acid. This is generally said to be due to minute traces of hydrocarbon formed from the carbon in the iron, and there is very much less carbon in aluminium. The smell seems to be good evidence of the decomposition of water at the soldered joint. A soldered joint will also sometimes evolve gas very slowly if left in water for some time.

There is another possible explanation which may be brought forward. The two explanations are not antagonistic, and the effects may work together. Aluminium alloys are generally very brittle, or even powdery, if they have a large proportion of aluminium and of the other metal. Thus aluminium with a little copper is a good alloy, and so is copper with a little aluminium, but an alloy of about equal parts is very brittle. Some of the alloys containing large proportions of aluminium and another metal tumble to powder spontaneously in a few weeks. If a metal or alloy is used as a solder, which forms with aluminium in any proportion a brittle or unstable alloy, the probability is the joint will go; for if you pass from the solder to the aluminium you must pass through strata of solder containing more and more aluminium until you are in pure aluminium, and therefore you must pass through a stratum of unstable alloy. This stratum must completely separate the solder from the aluminium, and if it is brittle, or if it spontaneously falls to powder in course of time, the joint must be bad. The obvious cure here is to use a solder that already contains more aluminium than the unstable alloys. Various solders of this sort are in the market.

As regards the uses of aluminium and its alloys enough has been written in the various technical journals. As already suggested, the pure rolled or drawn metal may come into much more extended use when it is supplied free from impurities, such as sodium and silicon. There are other uses than mechanical to which aluminium may be largely applied in the near future. Its great affinity for oxygen, which is its worst characteristic in mechanical work, is its merit in chemical and metallurgical applications. A little aluminium greatly improves many cast metals. It may be that the metals contain dissolved oxide. Copper, for instance, is apt to contain dissolved oxide, which deteriorates it, and is stirred with a green pole before running off. [It was a Cambridge undergraduate who asked his coach if a blue pole would do as well.] It is quite possible that such traces of oxide are reduced at once by aluminium, and that the alumina is insoluble in the molten metal, and rises out at once.

Aluminium can also be used to replace other metals, as it has a very strong affinity for oxygen, sulphur, and chlorine. Thus Vautin makes chromium by heating aluminium with a salt of that metal. Aluminium heated with sulphide of iron yields pure iron with no trace of carbon, a substance that is not familiar to many. As in such cases the products are not easily volatile, and as the action disengages a great deal of heat, enormous temperatures may be obtained in this way. In this way almost any metal may be obtained, as few have such avidity for oxygen, chlorine, or sulphur.

The amalgam of aluminium, or amalgamated aluminium, can also be used as a reducing agent in organic chemistry. It decomposes water rapidly, and reduces many organic compounds. It was generally thought that water must be present for the reduction to take place. This is probably the remains of the nascent hydrogen notion of reduction. People saw bubbles of hydrogen come off zinc in dilute acid, and they found reduction of reducible salts took place, so they jumped to the conclusion that the reduction was the result of the nascent gas, not merely another effect of the same cause. Wislicenus and Kaufmann have finally shown that the amalgam works without water; absolute alcohol, previously freed from all traces of water by amalgamated aluminium, being used as the solvent. It is a question of price how far aluminium may come in in the organic colour industry.

There is a difficulty about electroplating aluminium. It seems as if it might be possible by using a very high current density, just as sodium can be deposited from caustic. It may also be possible to deposit an aluminium alloy from an aqueous solution, as alumina has great affinity for some metals, incandescing on alloying, just as sodium does when dropped into mercury. Various accounts of processes of plating aluminium from aqueous solutions have appeared, but I, for one, have never seen a decent sample of the results. It is, by another process, quite easy to coat iron or copper with either aluminium or aluminium bronze and to produce a thick and impermeable coating, which is quite permanent. This coating is rough, however, and has to be filed up and polished, and it is difficult to do this without occasionally getting through the coating down to the metal underneath. Such a coating may be very useful for large objects exposed to rough usage or to the weather, as merely sand-papered up or pickled it has a handsome appearance.

The further cheapening of aluminium seems to depend on perfection of detail in manufacture which will be caused by keen competition. Cheaper methods, or rather cheapened methods, of producing pure alumina will gradually be introduced. There has been a good deal of talk recently about making aluminium from the sulphide; but it is difficult to say how far any sulphide process has been reduced to practice. It might give purer aluminium, and take less power. It might also save expense in anodes, as at present the anodes are burned just as much as if they were used for reducing alumina in a furnace. The use of sodium for replacing aluminium seems quite a thing of the past. There seems much more chance of aluminium being obtained by furnaces without electrical aid. The Cowles furnace really seems to work by temperature alone. The heats of combination do not necessarily settle whether an oxide will be reduced by carbon or not. It may be that the very high temperature is necessarily only to bring the carbon and alumina into contact. Either the alumina may melt, or the carbon may volatilise. A solution of alumina in a haloid salt is not easily reduced by carbon, however.

The Electrolysis of Fused Salt.

The manufacture of sodium and chlorine, or sodium and bleaching powder, from fused salt direct seems so absurdly simple and easy, that it is a very tempting problem; and if there were not very much more serious difficulties than appear at first sight, such a process as the simple electrolysis of melted salt would very soon oust all others. If a simple method could be devised, sodium could be made at a few pounds per ton. It would be used in very large quantities for the reduction of aluminium, and for replacing iron in the making of cyanides for gold extraction. It would doubtless also be used in innumerable other processes where a cheap and powerful reducing agent could be employed. All this is, however, a small matter; caustic and carbonate would be made from the metal. Instead of a ton of caustic soda, a papermaker would buy 11½cwt. of sodium, which he would convert into hydrate by treating with water. At present we need hardly trouble ourselves about means of treating sodium with water by the ton. It could, of course, be done. The hydrogen might or might not be utilised, and in some cases it might be worth while to get electrical energy by using the sodium in cells. This is unlikely, however; and we are not yet sufficiently near the economical manufacture of sodium to discuss its uses at length.

The difficulties in the way of the direct electrolysis of salt are enormous. In the first place, it must be fused. If it is heated by a furnace, it must be in a suitable vessel. Most kinds of stoneware and earthenware are attacked by fused salt, and are also likely to crack. Iron is the most promising material, but in time it will probably oxidise and scale away. The cost of thick cast-iron pots, something like those used in finishing caustic, might not be excessive. It might be possible to heat the salt by the current that electrolyses it. With a given fall of potential spent on the resistance of the electrolyte, it is easier to keep a large vat hot than a small one, so this method can only be used economically on a large scale. The containing vessel may then be practically solidified salt.

(To be continued.)

Simla.—According to *Indian Engineering*, very sanguine expectations are expressed of having an electric installation in Simla. A great many enquiries have been made by contractors, but only two have been left in—Kilburn and Co, of Calcutta, and Crawford, of Bombay. An attempt will be made to get the power from the Sutlej, a distance of about 15 miles from Simla. The estimate of the expense has been lately considerably lowered, and the Municipality expect tenders to be low enough to permit of at least one offer being considered and accepted. The time for tendering had not elapsed at the time the mail left.

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CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Bucharest.—Tenders will be received at the Mairie, Bucharest, on November 16 for two stand-by steam-engines for a water-power electric generating station at Grozavesti.

Brussels.—Among the contracts for the supply of stores to the Belgian State Railways, tenders for which are receivable at the Brussels Bourse on October 21, is lot 110, consisting of various sizes of electric light carbons.

Wolverhampton.—Tenders are required for an electric lighting heating and cooking plant for the Victoria Hotel, Wolverhampton. Specification may be seen on application to Mr. Thomas J. Barnett, secretary, 25, Darlington-street, Wolverhampton.

London.—Tenders will be received on October 26 for the supply of red fir telegraph poles for the Postmaster-General. Also for creosoting the poles. Particulars and forms of tender are obtainable from Mr. C. E. Stuart, controller of stores, General Post Office, London, E.C.

Brussels.—Tenders will be received on October 21 for the supply to the Belgian telegraphic service of (1) a quantity of galvanised iron wire, (2) various lengths of cable for riverine, submarine, and land service, and (3) a quantity of bare and insulated copper wire. No details are advertised as to the amounts required, but particulars are obtainable at the Brussels Bourse.

Werl (Germany).—The Local Authorities propose to submit to tender the construction and maintenance of an electric power and lighting generating station, and also an electric tramway from Werl to Wikede, with an eventual extension to Hamm. Further particulars will be obtainable at the Rathhaus, Werl-i.-Westf., Germany. The date for the tenders is November 3.

Cologne.—Tenders are required by the Municipal Authorities for the construction and working of electric tramways in the city of Cologne to an aggregate length of 20·3 kilometres (12½ miles). Specifications, plans, and particulars are obtainable for 10 marks (10s.) from der Registrateur B, des Oberbürgermeisteramt, Köln, Germany, and tenders must be in by November 6.

Madras.—Tenders are invited for the lighting by electricity of Government House, Madras, including the banqueting-hall and aide-de-camps' bungalow, and also for the lighting of Government House, Guindy, including the military secretary's bungalow. For particulars application must be made to the consulting architect to the Government, Chepank, Madras. Tenders will be opened on November 11, 1896.

Monmouth.—The Corporation require tenders for the following contracts: No. 1, machinery (consisting of turbines, alternators, steam-engines, boilers, electric motors, sewage pumps, etc.); No. 3, cast-iron pumping main; No. 4, electric lighting mains. Tenders are to be in by November 2. All particulars are to be obtained from Messrs. Bramwell and Harris, engineers, 5, Great George-street, Westminster.

Brussels.—Tenders will be received on October 21, at the Bourse, Brussels, for installing the electric light at the Arlon Railway Station, including the offices and works. Particulars are obtainable at the Brussels Bourse. La Société national des chemins de fer vicinaux will receive tenders up to October 28 for the conversion of about 14½ miles of tramway in the suburbs of Charleroi into electric lines on the overhead system. Particulars are obtainable, price 1fr., from the office of the Société, Brussels, rue de la Science 26.

Bradford.—The borough electrical engineer is prepared to receive tenders for the following meters—viz., 117 Aron meters, 86 Frager meters, 24 Edison meters, 21 Oulton and Edmondson meters. A list giving details and capacity of the above meters can be had on application to the Electricity Office, Town Hall, Bradford. Tenders are to be endorsed "Tender for Meters," and to be addressed to the Borough Electrical Engineer, Town Hall, Bradford. All meters are guaranteed to be in good condition and working order.

Madrid.—The Secretary of State for Foreign Affairs has received a despatch from H.M. Chargé d'Affaires at Madrid stating that a free public competition is announced in the *Gaceta de Madrid* of September 4 for the grant of the contract for the construction and establishment of three submarine cables to join the islands of Luzon, Panay, Negros y Cebu, in the Philippine Archipelago. Tenders must be lodged within 90 days of the publication of the conditions at the Spanish Ministry of the Colonies, accompanied by a deposit of 50,000 pesetas. The particulars received can be seen at the Commercial Department of the Foreign Office between the hours of 11 and 6.

London, W.—The Great Western Railway Company require tenders for the supply from December 1 next to November 30, 1897, of telegraph instruments, telegraph apparatus, copper wire, G.P. wire, etc., telegraph ironwork and tools, telegraph drysalteries, carbons for electric light, telegraph poles, etc. Samples and patterns may be seen at Swindon from 12th to 23rd inst. on application at the office of the Stores Superintendent at Swindon. Specifications, with forms of tender, may be obtained at the offices of the Stores Superintendent at Swindon. Tenders, addressed to Mr. G. K. Mills, secretary, Paddingdon Station, London, and marked outside "Tender for Stores," will be received on or before 26th inst.

Letterkenny (Ireland).—The Commissioners of Public Works, Dublin, invite tenders up to 12 noon on 19th inst. for (1) supply and erection of poles and one telegraph wire from Londonderry to Letterkenny, a distance of 24¾ miles; (2) supply and erection of poles and two wires from Londonderry to Letterkenny, a distance of 24¾ miles; (3) supply and erection of poles and one wire from Tooban to Letterkenny, a distance of 18½ miles; (4) supply and erection of poles and two wires from Tooban to Letterkenny, a distance of 18½ miles (all to be according to Post Office standard specification); and (5) making telephonic communication from Londonderry to Letterkenny. Address, Mr. P. J. Tuohy, secretary, Office of Public Works, Custom House, Dublin.

London, E.C.—Tenders will be received until 10 a.m. on 26th inst. (*a*) for the supply of red fir telegraph poles, to be delivered in London, King's Lynn, or Sutton Bridge, and at Northumberland Dock (River Tyne), West Hartlepool, Hull, or Grimsby; and (*b*) for creosoting the poles with 10lb. or 12lb. of creosote to the cubic foot, as may be directed, for the Postmaster General. The poles to be felled between November 2, 1896, and March 1 1897, and to be delivered during the following summer at the port at which the creosoting is to be performed. Butt-sections, from not less than three poles to show the quality of timber offered, must precede or accompany the tender of any person who has not already supplied the Postmaster-General with poles. Forms of tender, containing all particulars, may be obtained on application to Mr. Chas. E. Stuart, controller of stores, General Post Office, E C.

London, E.C.—The Shoreditch Vestry require tenders for the erection of an underground transformer sub-station at the intersection of Great Eastern-street and Curtain-road, Shoreditch, E.C., together with stairways, street refuge, and fittings complete. Specification, quantities, and forms of tender can be obtained and the drawings can be seen on and after 12th inst. at the office of the engineers, Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster, on payment of a fee of £3. 3s., which will be returned on receipt of a bona fide tender. The contractor whose tender is accepted shall enter into a formal agreement, under seal, with sufficient sureties for the fulfilment of contract. Trade union rate of wages and hours to be observed. Sealed tenders, endorsed "Electricity Supply, Tender for Sub-station," to be sent at or before noon on 19th inst. to Mr. H. Mansfield Robinson, clerk, Town Hall, Old-street, E.C.

RESULTS OF TENDERS.

Hanley.—For the supply of a second engine for the electricity works, for the Town Council, the tender of Messrs. Ferranti and Co., at £3,300, has been accepted.

London, E.—The tender of Mr. Fife, at £4,087. 10s., for the electric lighting of the Guardians' establishments has been accepted by the Mile End Guardian Board.

Worcester.—The Corporation have accepted the tender of Messrs H. G. Keen and Co., of The Avenue, Cross, for removing the gasfittings from the three sunlights in the assembly-room, and wiring the same for the electric light, according to the specification prepared by the electrical engineer, for £34.

Brussels.—The following tenders were received for an installation of the electric light to the Palais des Académies: Bouckaert and Co., Brussels, £370; the Phaeton Company, Brussels, £414; G. Boty, Brussels, £422; the Electrical Manufacturing Company at St. Gilles, £502. There was also one tender which was irregular, and therefore not considered.

Wandsworth.—The tender of the Private Wire and Telephone Installation Company, of 110, Cannon-street, E.C., has been accepted by the Wandsworth and Clapham Guardians for a telephone installation at "Tooting Home," a large building now nearing completion. Telephones are to be fitted in all the departments on each floor, and the wiring is to be on the intercommunication system, and all the instruments are to be magneto-ringing, fitted with Hunning's transmitters.

BUSINESS NOTES.

Western and Brazilian Telegraph Company.—For the past week the receipts were £2,895.

Globe Telegraph and Trust Company.—The directors have declared an interim dividend of 1s. 6d. per share on the ordinary shares.

Folkestone.—The Corporation have approved of the electric lighting draft agreement, and it will now be submitted to the Board of Trade.

Colchester.—A letter was read at the Town Council meeting from the ratepayers' association expressing disapproval of the electric lighting scheme.

Globe Telegraph and Trust.—The directors announce interim dividends of 1s. 6d. per share on the ordinary shares, and 3s. per share on the preference shares.

Wells.—A letter was read at the Town Council meeting from the Board of Trade approving of the method by which it was proposed to light the city by electricity.

Bootle.—The Town Council have decided to retain the electric supply, put their powers into force, select a site for the generating station, and obtain expert assistance.

Spanish Electric Railway.—In the *Revista de Obras Publicas* there is a long article (to be continued) by Mr. E. Azarola on the subject of an electric railway from Pamplona to Estella and Logroño.

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Oriental Telephone and Electric Company, Limited.—The Board announce an interim dividend of 4d. per share.

St. Pancras.—At the meeting of the Vestry a petition was presented from the ratepayers and residents of Longford-street with reference to the better lighting of that street.

Dublin.—The trailer cars have been discontinued for the winter season on the electric trams running between Haddington-road and Dalkey, and the motorcars only are now used.

Llandrindod Wells.—At the Urban District Council meeting the seal of the Council was ordered to be affixed to the agreement with the electric light company for lighting the streets by means of electricity.

Turriff.—The mansion house of Carnoustie has been fitted throughout with electric light generated by turbine power about half a mile from the house, to which it is conveyed by means of overhead wires.

Order Form.—We have received a specimen of a very handy order form, in the shape of a large reply postcard, from the Reliance Lubricating Oil Company, 19 and 20, Water-lane, Great Tower-street, E.C.

Arundel.—It is proposed to form a telephone exchange for the area of Arundel, Chichester, Littlehampton, and Bognor, and meetings have been held and committees appointed to help forward the matter.

Submarine Cable Trust.—A corrected notice is issued stating that the payment by Messrs. Glyn, Mills, and Co. on and after October 15 of £2. 7s. 6d. is on account of the coupon due on that date, and is not the balance.

Dissolution of Partnership.—G. J. S. Lock, H. M. Lock, and E. C. H. Tiffin, electrical engineers and manufacturers of electrical fittings, Berners-street, W., under the style of Moutrie and Co., have dissolved partnership.

Atlas Steamship Company.—The new steamer "Altai," which was recently launched, is to be fitted throughout with electricity, the machinery for which is to be supplied by Messrs. Clarke, Chapman, and Co., Limited.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending October 11 amounted to £1,076, as compared with £1,118 in the corresponding week of the previous year, being a decrease of £42.

Indo-European Telegraph Company, Limited.—The Board have declared an interim dividend for the half-year ended June 30 last at the rate of 5 per cent. per annum, free of income tax, payable on and after November 1.

Fleetwood and District Electric Light and Power Syndicate, Limited.—This Company has been registered, with a capital of £20,000, to carry on at Fleetwood or elsewhere the business of an electric light company in all its branches.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ending October 9 were £2,278. 17s. 11d., compared with £1,675. 10s. 1d. for the corresponding period of last year, being an increase of £603. 7s. 10d.

South Shields.—The Town Council have decided to apply to the Local Government Board for their sanction to the borrowing by the Council of the sum of £7,500 for the purpose of providing the additional plant recommended by the electrical engineer.

Electric Free Wiring Syndicate, Limited.—This Company has been registered, with a capital of £1,000 in £1 shares, to carry on business as electricians, mechanical engineers, suppliers of electricity, and manufacturers of and dealers in electrical apparatus.

Johannesburg.—A telegram from the French Bank of South Africa states that the application of the Johannesburg Tramway Company to the Government of the Transvaal to permit the use of electricity in the place of animal traction will be shortly granted.

Blackpool.—A long discussion took place at the Town Council meeting on the Electric Lighting Committee's minutes, as some of the members thought information as to the totals of certain tenders was being withheld, but in the end the minutes were passed.

Brighton.—In spite of the heavy seas during last week's gale, both Volk's electric railway and the Rottingdean electric railway and car escaped practically without damage. A small portion of the earth bank on the Madeira-road was washed away, but this has been repaired.

Calcutta.—An application from Mr. Archibald A. Crawford, agent for the Allgemeine Elektricitats-Gesellschaft, Berlin, for the consent of the Corporation to his application to the Local Government to supply electricity to Calcutta, under Act IX. of 1895, has been complied with.

Standard Time Company, Limited.—This Company has been registered, with a capital of £10,000 in £1 shares, to acquire any patents, patent rights, etc., relating to improvements in apparatus for the regulation of time, and to acquire or manufacture and deal with telephones, etc.

City and South London Railway.—The returns for the week ended October 11 were £965, compared with £916 for the corresponding period of last year, being an increase of £49. The total receipts for the half-year 1896 were £13,681, compared with £12,774 last year, being an increase of £907.

Keswick.—At the Urban District Council meeting a letter was read from the Keswick Electric Light Company asking the Council to appoint two representatives to meet a like number of the directors on the 10th inst. to discuss matters. It was decided to agree to the request, and Messrs. Wood and Philipson were appointed as the deputation.

Direct United States Cable Company, Limited.—The Board have resolved upon the payment of an interim dividend of 2s. 6d. per share, free of income tax, being at the rate of 2½ per cent. per annum, for the quarter ending September 30.

Beacon Engineering Company, Limited.—This Company has been registered, with a capital of £5,000 in £5 shares, to carry on the businesses of iron and brass founders, mechanical engineers, electrical engineers, etc., in all their respective branches. Registered office: 32, Victoria-street, Manchester.

Coventry Motor Company, Limited.—This Company has been registered, with a capital of £10,000 in £1 shares, to manufacture and deal in and with automotor cars, carriages, cabs, omnibuses, tramcars, railway coaches, etc., and also to carry on business as electrical and general engineers, machinists, millwrights, etc. Registered office: Conduits-yard, Coventry.

Aerial Torpedo Syndicate, Limited.—This syndicate has been registered, with a capital of £5,000 in £1 shares, to carry on business as manufacturers of and dealers in aerial vessels of every description, and to acquire and turn to account any patents, patent rights, etc., relating thereto, as mechanical engineers, etc. Registered office: 5 and 6, Great Winchester-street, E.C.

Bangor.—A long and final discussion took place at the special meeting of the Town Council on the question of applying for a provisional order, and in the end it was decided that the Council should apply at the next parliamentary session for a provisional order to enable them to supply electricity within the borough of Bangor and such parts of the parishes of Pentir and Llandegai as might be necessary.

Stretford.—On the minutes of the General Purposes Committee being read at the District Council meeting, the Clerk said the Council had given the sub-committee power to deal with the matter of electric lighting. The sub-committee had retained the services of Mr. F. Bennett, engineer, who would prepare a short detailed scheme, and a report would be presented to the Council at a later date.

Bury St. Edmunds.—At a meeting of the Town Council Mr. Turner (chairman of the Electric Lighting Committee) moved that in order to provide a sliding scale of charges for electricity (as charged in some other towns), if found to be advisable, it be recommended the maximum charge of 8d. per unit instead of 6d. be inserted in the provisional order. Mr. Cornish seconded the motion, which was adopted.

Madras.—At the instance of the Government of India the Madras Government has called upon the agent and manager of the Madras Railway to furnish it with a report showing how the system of electrical communication in trains between passengers and guards and drivers, in use upon the line, has worked, and whether the system is now sufficiently perfect to justify its general adoption on other lines of railway in India.

The Motorcar.—Motor cycles are among the latest productions at Coventry. These will be placed upon the market at the beginning of next month. The London Road-Car Company, whose rolling-stock now totals 900 vehicles, intend to give motor-cars a trial when the law permits. Coventry accordingly hopes to have an opportunity of supplying a considerable number of cars for the omnibus trade in the near future.

Monmouth.—At the Town Council meeting, the Mayor, in reply to questions, stated that about a fortnight previous he had written to Messrs. Bramwell and Harris asking when they would be ready with the specifications for tendering, and they replied that they would be ready in about three weeks from then, so that he expected to hear from them shortly. We give further particulars under the heading of "Contracts Open."

Wimbledon.—It was stated at the Urban District Council meeting that a letter had been received from Mr. Morse, solicitor to the County of London and Brush Provincial Electric Lighting Company, indicating their intention of applying for a provisional order. The clerk was directed to acknowledge the communication, and state that as the Council had themselves decided to apply for a provisional order they could not consent to the company doing so.

Exeter.—The electric light station continues to work favourably, and there is an increasing demand for the light. By hurrying on the new machinery it is hoped they would be able to give an all night supply next month. The committee are considering the advisability of laying down plant if there is sufficient demand for supplying motor power. There has been a certain demand, but not sufficiently definite at present to justify the committee in asking the Council for a loan of £3,000.

Explosion on a Telegraph Ship.—The Telegraph Construction and Maintenance Company's steamer "Scotia," bound from London to Vigo, put back to Plymouth a few days ago, and reported that at four o'clock on Thursday morning in last week one of the officers went into the forepeak with a naked light, when an explosion of corrosive paint occurred, both sides of the bow being blown out and six men injured. The watertight bulkhead alone prevented the ship from sinking. The accident occurred south of Ushant.

Brazilian Submarine Telegraph Company, Limited.—The accounts for the year ending June 30 last, subject to audit, show a profit sufficient to enable the directors to recommend a final dividend of 3s. per share, making with previous distributions a total dividend of 6 per cent. for the year, and also the payment of a bonus of 2s. per share, both free of income-tax, which together will amount to £32,500, leaving a balance of £31,060, of which sum £20,000 has been placed to the reserve fund and £11,060 carred forward.

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New Companies and Electricity.—Among the new companies registered and which take power to manufacture and supply electric current and appliances, telegraph and telephone works, etc , are Middlemore and Lamplough, Limited, Lyons Brewery and Malting Company, Limited, Lake George Mines, Limited, Brock's Goldfields of the Northern Territories of Australia, Limited, the Golden Link Consolidated Gold Mines, Limited, and the Manighatta Company, Limited.

The Electric Tramway at Niagara.—The Buffalo and Niagara Falls electric railway operates a double tracked road between Buffalo and Niagara Falls, 15 miles. Operation was commenced September 20, 1895, and the following results cover the period to June 30, 1896, being nine and one-third months: gross earnings, £14,700; operating expenses, £9,990; net earnings, £4,710; interest on bonds amounted to £5,560; and taxes, £320—total, £5,880, leaving a deficit balance for year of £1,170.

Ipswich.—The Corporation having consulted Prof. Kennedy as to the cost of two schemes of electric lighting which they submitted, he has reported that one would cost £30,000 and the other £42,000. The Council have instructed the Electric Lighting Committee to issue the necessary notices and to take all necessary steps to enable the Council to apply for a provisional order under the Electric Lighting Acts in the next session of Parliament, on the line of the area (*d*) referred to in the committee's report. This is the larger scheme.

Llanelly.—The Highway Committee having given Mr. Howell permission to erect overhead wires temporarily to supply the arc lamps he has put up in the New Dock-road as an experiment, Mr. Griffiths raised an objection at the meeting of the Council, and said they had already refused permission to the Old Lodge Company to lay their electric light wires overhead. He moved an amendment that Mr. Howell be instructed to lay his wires underground, but it was explained that the permission was only temporary, and the amendment was lost.

Chester.—The Town Council have authorised the Improvement Committee and the Town Hall Committee to have the public market and annexe and the town hall respectively wired and fitted up for lighting by electric light under the supervision of Prof. Kennedy and the city surveyor. The Town Clerk (Mr. S. Smith) said the tenders for the lighting of the town hall ranged from £473 to £772, exclusive of the cost of bringing the service into the building, which was estimated at £30. A resolution was carried sanctioning the lighting of the library also.

Cork.—At the meeting of the Public Works Committee, a discussion took place with reference to the electric tramway scheme, and arising out of this, the town clerk (Mr. A. McCarthy) stated that Mr. Murphy had asked him if they could get any part of the corn market grounds upon which to erect a building for the purpose of keeping the elecric dynamo there. The corn market ground was one of the sites recommended, and he (the town clerk) thought the back of it would be a most suitable place for such a purpose if the trustees would be agreeable to the suggestion.

Bristol.—The Sanitary Committee have approved the estimate for the half-year ending March 25, 1897. The cost of electric lighting in public streets is set down at £2,100; last year for the same period it was £2,380. The electric appliances for the Eastville line are being provided as rapidly as possible. The standards and arms are all fixed. The overhead wire has been carried along the track for about half the distance, and the plant necessary to generate additional electricity to serve the newly-laid line is being fixed at the power station at St. George. The Ashton-gate new section is becoming popular.

Tunbridge Wells.—The Lighting Committee reported at the meeting of the Town Council that they had decided to take expert opinion as to the increase of the assessment on the electric light works. Application to extend the lighting mains in Boyne-park and Molyneux-park were acceded to on the usual agreement. The question of utilising the open-air bath in connection with condensing plant was abandoned, the surveyor reporting that the cost of laying a pipe would be £500. It was decided to supply current for motive purposes and motorcars for 3d. per unit. It was decided to give a constant service as soon as the steam-pipes are completed.

Wakefield.—At a recent City Council meeting Alderman Sherwood, chairman of the Electric Lighting Committee, in moving the adoption of the minutes, stated that everything in connection with the electric lighting works was progressing very satisfactorily. He also stated that the City Council had practically agreed with the West Riding County Council for supplying the electric light to their offices now in course of erection. He believed the city would without doubt have the electric light on August 1 next. The price of it would be 6d. per unit, with a rebate to 4d. The Council appeared to regard the statement as very satisfactory.

Burnley.—At the meeting of the Town Council, Councillor Macfarlane said the electric cable to Bank Hall had been carried from under the footpath up the side of the wall and then taken through. It had simply been covered with an iron plate, which had not been properly secured, and one portion of the cable was left exposed. He had seen lots of children playing about there, and he thought it was dangerous to leave a cable in that way. Councillor Bibby said the electrical engineer assured the committee that there was no danger whatever to anyone touching the cable. If there was any defect in the fastening of the plate that would be remedied.

Sowerby Bridge.—A committee has been appointed by the District Council, consisting of Messrs. Wrigley, Wilson, Joseph Greenwood, Lodge, and Sutcliffe, to consider the feasibility or otherwise of providing electric light for the gasworks, the District Council offices, and the public baths. We understand that at these three departments, at the present time, a total of 1,250,000ft. of gas is consumed annually. The electric light, some of the members contend, could be introduced at less cost, especially as as both the gasworks and the baths there are appliances that could be utilised to provide the motive power required for the running of the electric plant laid down.

Bolton.—At a meeting of the General Purposes Committee, matters relating to the extension of tram traction outside the borough and other subjects were discussed at length. The town clerk was instructed to communicate with the districts of Horwich, Tonge, Little Hulton, Over Hulton, and Deane with respect to the extension of tramways to their districts The town clerk was instructed to prepare and give notice of a Bill, to be promoted by the Corporation, to enable the Corporation to work the Bolton and suburban tramways; to authorise the extension of the tramways; and to authorise the supply of electricity for tramways and other purposes outside the borough, etc.

Waterloo-with-Seaforth. — The plan for a new generating station for the Liverpool and District Lighting Company, Limited, on the west side of Brighton-road, Waterloo, was disapproved at the Urban District Council meeting, as the building was shown to be brought forward beyond the front main wall of the house or building on the west side. Mr. Peters pointed out that other buildings in the same street had been approved. Mr. Watts hoped the chairman would pay great attention to that matter. The Chairman said he had the pleasure of sitting on that committee, and could assure him the plans were not gone through without them receiving the greatest consideration from all concerned.

Newmarket.—A special meeting of the Urban District Council has been held to consider a motion that the Council apply to the Board of Trade for a license or provisional order authorising the Council to supply electricity for public and private purposes within the district. The resolution was moved by Mr. Westrope and seconded by Mr. Segrott. Mr. Rodrigo moved as an amendment that the question be adjourned for four weeks, the object being to allow a public meeting being called. The discussion was being continued by the vice-chairman when a member interrupted, and, on being called to order by the chairman, said when a man got up and told lies he must interrupt. As he refused to withdraw this expression the proceedings were suspended, and the meeting adjourned for a fortnight.

Paisley.—The Electric Lighting Committee have had under consideration the following places as sites for the central station in connection with the introduction of the electric light: Carlile's Mill (a piece of ground to the east of Auchentorlie House), Kirkwood, Baird, and Co.'s works at Blackhall, and Morrison's property in Dyer's-wynd. Mr. Teague, the resident engineer, has been instructed to prepare a rough outline of a scheme for a station on each of the sites in Blackhall and Seedhill roads. The committee have also considered the propriety of providing a storage battery for the George A. Clark Town Hall, which would afterwards be available for the central station, but nothing definite was decided on. Mr. Teague informed the committee that the cost of the battery would be about £400.

Southport.—The electrical engineer (Mr. Charles D. Taite) has prepared a report relating to the Corporation electricity works. He states that the capacity of the machinery at present installed is 375 units, but as sufficient plant is held in reserve to take the place of the set utilised in case of accident, the working capacity of the works must be taken as being equal to an output of 250 units per hour. He estimates that by March 31 next the present available plant will be practically fully loaded, rendering additional plant for the following winter a necessity. To meet the increased demand anticipated, a 300-unit alternator and engine to correspond will be required, making the full capacity of the station 675 units. The cost of this new alternator, with necessary additions, he estimates at £12,000, making a total expended capital of £58,882.

Maidenhead.—At the Town Council meeting Councillor Wilton moved, in acordance with notice, "That the Lighting Committee be requested to confer with the town clerk as to the position of the Council in the matter of public lighting, with the view to the undertaking themselves to supply gas for the public lighting." Councillor Wilton gave statistics of the cost to the town of public lighting during the past three years, and spoke in favour of the Council taking the matter into their own hands. On the suggestion of Councillor Gardner, the speaker agreed to withdraw the word "gas" so that the question of lighting by other means might be considered. Councillor Gardner seconded. Councillor Good considered that the lighting of the town should be by means of electric light, and, after some discussion, the motion as altered was carried.

Catalogues.—We have received from Messrs. Wilhelm and Co, 132, Wool Exchange, Coleman-street, London, E.C., a catalogue of electricians' tools, etc., and also an illustrated price-sheet of the arc lamps manufactured by K. Weinert, of Berlin, of which Messrs. Wilhelm are the sole agents. These lamps seem to have one strong feature in their favour, and that is the shortness of the cap. Messrs. Weinert are also sole agents in the United Kingdom for the "Hard" incandescent lamps.—The Jandus Arc Lamp Company send us their latest catalogue, which contains some good illustrations and details and a heap of Press cuttings.—We have also received from Messrs. Peto and Radford a full catalogue of their pocket and portable accumulators, ranging from two to six volts, lanterns and lamps, etc., and a fascintating display of electric jewellery.

Extension of Premises.—Messrs. Royce and Co., of Hulme, Manchester, owing to the increasing demand for their well-

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known types of dynamos, motors, arc lamps, etc., have found the extension of their workshops necessary, and these extensions, already practically complete so far as building is concerned, are now being equipped with the essential plant. Separate motors will be installed in the new building for driving the various machines, lathes, etc., and likewise in the older portions of the premises where such practice has not already been adopted. The special form of lampholder also manufactured by this firm has won deserved popularity on account of its simplicity of parts and freedom from the usual wooden cord grip, porcelain and metal being the sole elements in its construction. Large numbers of these holders are now being turned out.

Wareham.—At the meeting of the Town Council, the clerk read a letter on the subject of telephonic communication from the local manager at Bournemouth of the National Telephone Company, Limited, from which it appears that Wareham and Poole, and also Corfe and Swanage, are in that area, and that subscribers in these towns could be connected with Bournemouth, Boscombe, etc., at a rental of £10 per annum, providing there was an exchange at these places. The company would open an exchange at Wareham if sufficient support were forthcoming and connect with Bournemouth, and thus with the Post Office wires to nearly all parts of the country. The Town Clerk stated a representative of the company had lately called upon him. He found the company were anxious to connect with Swanage and would possibly include Wareham, although less than the usual number of subscribers were forthcoming. It was resolved that no action in the matter be taken at present.

Shoreditch.—The Vestry have decided to apply for a further loan of £10,000 with which to carry out electric lighting works. Mr. R. F. Ferguson, the resident electrical engineer, has resigned his position in consequence of ill-health. The Vestry have decided to advertise for a permanent electrical engineer for the combined destructor and electricity undertakings, at a commencing salary of £250 per annum. The officer appointed will have to devote the whole of his time to his duties. The London Hydraulic Power Company have written to the Vestry stating that the Vestry's proposals as to charges on mains and services in Shoreditch were without precedent in the operations of the company, and they felt they were not being properly treated by the Vestry. A small fee for each permission to extend the mains and to lay services to cover any expenses to which the Vestry might be put ought, in their opinion, to be sufficient. The letter was referred to the Parliamentary Committee.

Buenos Ayres.—La Capital Tramways Company, Limited, has been registered, with a capital of £100,000 in £1 shares, to enter into an agreement for the acquisition of the tramway known as La Capital, and the benefit of certain tramway concessions granted by the Municipality of Buenos Ayres, in the Argentine Republic, for the construction of tramway lines in the city of Buenos Ayres, and for the using of electric force in regard thereto, together with all or any of the buildings, plant, rolling-stock, stock-in-trade, and other property connected with such undertaking, or acquired in reference to such concessions or any of them; to acquire any other concession or concessions for tramways, railways, or other public works, and to undertake and carry out the same; to carry on the business of an electricity supply company, whether for light, heat, power, or otherwise; as manufacturers of generators, batteries (primary or secondary), lamps, engines, motors, converters, meters, and other electrical appliances.

Monte Video Telephone Company, Limited.—The report of the directors for the year ending July 31, to be presented to the general meeting to be held at Winchester House, E.C., on 22nd inst., states that the accounts show a net profit for the year of £5,727, after providing for all working expenses in Monte Video and London, and after writing off amounts for bad debts and depreciation of office furniture. This amount, added to the sum of £711 brought forward from last year, leaves an available balance of £6,438. During the year a marked improvement has been made in the Company's service by the adoption of a new microphone. The whole outlay of this and other extensive additions to the plant has been charged to working expense. The number of subscribers is gradually increasing, and the general position of the Company is satisfactory. The directors recommend the payment of a dividend of 4 per cent. on the preference share capital (absorbing £5,600), and leaving the sum of £838 to be carried forward.

Sydney.—On August 12 the Hon. J. Young, Secretary for Public Works, moved that the electric tramway from Circular Quay, Sydney, to the Redfern railway station, and along Harris-street to the intersection of John-street, be carried out. The Minister, in speaking to the motion, said that reports from the Public Works Committee go to show that if this tramway be carried out it would probably carry a large number of passengers at a comparatively small expense, and would increase the number of the paying lines. The tramway is estimated to cost £123,000, but some additions may bring it up to £130,000. The annual interest and the estimated total working expenses amount to £32,487 per annum. The annual revenue is estimated at £45,000, leaving an estimated annual profit of £12,513 or over 10 per cent. He quite agreed with the Public Works Committee that the traffic in George-street would not be very much affected by the extension of the railway into the city. After a lengthy discussion the motion was carried on the following division: ayes, 35; noes, 24.

Halifax.—At the meeting of the Town Council the following resolution authorising the promotion of a Tramways Bill was passed by a very large majority: "That the Council do apply to Parliament in the next session for a Bill for all or some of the following purposes; to empower the Corporation to construct, lay down, and maintain tramways in the following streets in the borough of Halifax—namely, Church-street, Horton-street, Wards-end, Commercial-street, George-street, Silver-street, Bull-green, King Cross-street, King Cross-road, Commercial-street (north end), New Crown-street, and Gibbet-street. To empower the Corporation to work the said tramways or any portion thereof when constructed. To empower the Corporation to work the said tramways either by animal power or by steam, or electrical, gas, cable, or any other power. To enable the Corporation to make and maintain stations for generating electrical power on lands belonging to the Corporation or on lands to be acquired for that purpose. To empower the Corporation to levy tolls, rates, and charges for the use of the proposed tramways, and for the conveyance of traffic upon the same."

Levenshulme.—At the District Council meeting Mr. Tunaley, in accordance with a notice of motion given at a previous meeting of the Council, moved that that body apply to the Board of Trade for a provisional order authorising them to light the district with electricity. Mr. Coates seconded, and the motion was unanimously adopted. It should be distinctly stated, he said, that although the Council asked for an order it would not necessarily be put into operation—they would not necessarily undertake the work. All they desired was simply to protect the rights of the ratepayers so that they might have full control over anything connected with the work. The minutes of the General Purposes Committee, which were adopted by the Council, contained a statement by the chairman on the result of a conference which had been held between the surrounding authorities with reference to the supplying of the suburbs of Manchester with electricity. It was understood that the discussion and arrangements would be carried further at a forthcoming meeting, and the committee who attended on behalf of the Council were authorised to agree on behalf of the Council to such terms as they might think advisable.

Belfast.—At the meeting of the Harbour Board Mr. Lawther moved, pursuant to notice, "That the minutes of the general committee meeting of April 23, 1895, and May 7, 1895, respectively, confirming the recommendations of the Joint Works and Traffic Committees of April 18, 1895, relative to the supply of electric light to persons requiring it at Queen's Quay, and the minute of July last as to supplying Messrs Harland and Wolff, Limited, with 30 arc lamps of 1,000 c.p. each, at £10 each per annum, be rescinded." This was a matter which had got into a muddle. All the tenants were offered the electric light at the time the installation was made, and among those who accepted it were Messrs. Harland and Wolff. It was afterwards found that it would be a very expensive thing to do, and would practically absorb all the electric power. The Lord Mayor, it was only right to say, had advised the Board to keep their power in reserve for lighting Queen's-road and the Alexandra Dock, and only accepted the lighting for his firm with a view of using up the surplus power. Mr. Lytle said he would formally second the motion, not for the reasons stated by Mr. Lawther, but for the purpose of bringing the Board into order. The motion was passed.

Leeds.—A dispute has been proceeding at Leeds relating to the hours and wages of outdoor workmen employed by the National Telephone Company. The company recently gave their Leeds employés notice that they would in future be required to work 53 hours instead of 50 hours per week. There was, however, no offer of extra payment, and the reason assigned for the change was a desire to bring the working time into uniformity with that worked in London and other places. On the men putting in a plea for no greater addition to the time than two hours, and also for 1s. 6d. extra wages, the company offered 1s. by way of payment for the three hours under the new rule. A temporary settlement of the dispute has accordingly been arrived at, the workmen continuing their employment with the hours raised to 52 per week and the pay increased by the sum of 1s., pending confirmation by the general manager of the company. The same questions which have been agitating the Leeds telephone workers are a matter of concern to their fellows in Bradford, Hull, and Dewsbury. The Corporation accounts for the year ending March 25 last have been abstracted by Mr. Wm. Derry, the city accountant, and from that abstract we gather that the expenditure on electric light for the year has been £2 527.

Stafford.—The Gas and Electricity Committee reported at the Council meeting that, having considered the report of the electrical engineer, they recommended that, commencing with the ensuing quarter, the initial price for the supply of electricity be reduced from 8d. to 7d. per unit for any quantity up to an average maximum demand of 1½ hours per day during the two winter quarters, and three quarters of an hour per day during the two summer quarters; 4d. per unit remaining as the charge for all electricity used above such maximum demand. Alderman W. H. Peach, in moving the consideration of the report, said the series of decreases in the consumption of gas for the past four months had now ceased. Three new consumers of the electric light had been found during the month, who would take altogether something like 158 lamps. In reducing the price of the electric light, the committee believed they would be furthering the interests of that department, and some customers complained that the cost of the current was too high. Since the works were opened nearly a year ago the number of electric light consumers had about doubled, but if the same increase occurred during the next 12 months the committee would be much better able to meet their liabilities than if they adhered to the present charge.

Winchester.—A provisional order having been obtained from the Board of Trade at a cost of £350, which must be put in operation by June next either by a private firm or the Council, the Electric Lighting Committee reported at the Town Council

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meeting that they had received an offer from Messrs. Edmondson, Limited, of Great George-street, Westminster, to take over the order and carry out the installation. The following terms had been agreed upon: "The firm to repay the Council the cost of the order, make the installation works, etc., at a cost of £15 000, and the Corporation to have the option of taking over the affair by giving 12 months' notice. If this were given within seven years then they could purchase at the cost of the expended capital plus 15 per cent.; if after seven and less than 14 years, plus 10 per cent.; and if after 14 years, plus 5 per cent. The prices to large consumers per unit to range from 8d. to 6d. by sliding scale. All public lighting to be charged 4d. per unit. The Corporation to select the site of the works." The Mayor moved a resolution accepting these terms, and Mr. Stopher having seconded, it was carried. The present system of incandescent gas lamps in the streets will cease with the contract about 18 months hence, so that till then electricity will not be used in the streets. The compulsory area will be decided by the Council in due course.

Withington.—At a special meeting of the Urban Council the clerk (Mr. Roberts) submitted a report of the sub-committee on electric lighting, and it was resolved: "That the Council oppose any application made to supply electricity within the district by any other local authority or private undertaking, and that an application be made by the Council to the Board of Trade, under the Electric Lighting Acts of 1882 and 1888, for a provisional order, to be confirmed in the next session of Parliament, authorising the supply of electricity for public and private purposes within the area of the district of the Council, and any other areas that may be thought desirable." A committee was appointed, consisting of Messrs. Coombs, Blair, Harwood, Norquoy, Raby, Price, Provis, and Swarbrick, to take the necessary steps for obtaining the provisional order. It was further resolved to oppose the granting of a provisional order to the Manchester Carriage and Tramways Company to construct additional tramways in the district. The proceedings of the General Purposes Committee were also confirmed. The committee stated that a letter had been received from Messrs. J. H. Andrews and Butterworth asking if the Council would consent to an application on behalf of the company they represented for a provisional order to lay down tramways in the district, to be worked by electrical traction. The committee resolved that such consent should not be given.

Coseley.—At the District Council meeting, when the question of extending the gas lighting was being discussed, Councillor Wones thought it was quite a mistake to go on lighting the district with gas. All round them they saw districts and towns, even where they had gasworks of their own, introducing electricity for lighting purposes, and where it had been introduced more capital was being asked for for the purposes of extensions He urged the Council to give the matter full and earnest consideration, to take notice of what was being done all through the country, and not to spend money on gas until an estimate for the provision of electricity had been carefully gone into. The Chairman said the question of lighting the district by electricity or gas was not before the meeting. Councillor Rolinson said it was bearing on the question. In his opinion a mining district was the very place in which it would pay to lay an electric cable—in fact, the electrical engineer who was consulted on the matter looked upon Coseley as an ideal district for lighting by electricity. They were told that if they could get 1,000 consumers it would pay, but no one had told them that if they lit the district with gas they would ever make a penny profit. It could be proved that electricity was more economical than gas, and he hoped too much money would not be spent on gas till the electric lighting question had been further considered. On the last occasion they had the worst of the vote but the best of the argument.

Hampstead.—The Clerk read a letter at the Vestry meeting from the agent for the Norwich Union Fire Insurance Society, stating, with reference to the policy for insurance of the electric lighting station, which fell due on September 29, that, in accordance with the instructions from the Fire Offices Committee, the rates on £13,000 for the building and contents, exclusive of dynamos, would be increased from 5s. to 10s. 6d. per cent., making the total annual premium £89. 5s. as against £53. 10s. Mr. Richardson protested against the short notice given by the company. The chairman explained that all the fire insurance companies met recently and agreed to raise the tariff of insurance on all electric lighting stations. The notice was short, but he thought they were bound to draw the cheque. It was decided to draw the cheque for the amount claimed. Upon the suggestion of Mr. Hanhart the letter was again referred to the Finance Committee, with instructions to report on the whole question. Mr. Reed, chairman of the Lighting Committee, referred to the failure of the electric light in Heath-street Chapel the other Sunday evening, and, for the information of the ratepayers, stated that the fault was not in the public supply. Mr. Harper asked when the report of the Lighting Committee on the question of lighting the public thoroughfares with the electric light would be ready. Mr. Reed replied that he hoped to be able to bring up a report in a month's time. In reply to Mr Aitchison, Mr. Reed said that the Vestry had no power to supply electricity in an adjoining parish.

Bradford.—At a meeting of the Town Council, Mr. W. C. Dixon (chairman of the Gas and Electricity Supply Committee) moved the adoption of the minutes of that body. The minutes showed that the committee had entered into the tenancy of premises No. 204, Swan-arcade, with a view to utilising them for the exhibition and sale of electrical appliances in order to encourage the use of electricity within the borough for the purpose of lighting and as a means of motive power. Mr. Dixon said that the committee had decided to lay a new cable up Kirkgate at a cost of £1,400. There were now about six sets of feeders from the electricity station, and until recently the committee had not been able to ascertain how many amperes each set of cables had had to convey, the result being that some of the cables had been very much overloaded, whilst others had not been conveying their full quota of current. An instrument which registered the amount of current conveyed by each cable had recently been procured, and it had been found that the Kirkgate cable, which was constructed to convey 540 amperes, had had 940 amperes forced along it. That meant a great waste of current, and the new cable was being laid in order to avoid that waste. Alderman J. Sheldon said that tradesmen in the centre of the town were much annoyed and inconvenienced by the frequency with which the main streets were taken up for the purpose of laying gas or electricity mains. Mr. Dixon said that the Gas and Electricity Supply Committee were now, wherever possible, laying down conduits, through which the cables could be drawn. By that means much of the digging up of thoroughfares would in the future be avoided. The minutes were adopted.

Wigan.—Alderman Holmes, in moving the confirmation of the Gas and Electric Lighting Committee's proceedings at the meeting of the Borough Council, said he desired to call the attention of the Council particularly to the meetings on September 22 and 23, wherein they would find that the committee recommended to the Council the postponement of the introduction of electric light into the town. That action was taken because the committee felt that at the present time a new burden would very shortly be placed on the ratepayers of the town by the introduction of an additional water supply. In addition to that, the great body of shopkeepers to whom the committee must in future look for the adoption of the electric light, and therefore its financial success to the town, were at the present time in a state of what might be termed depression, or, what they admitted themselves, a state of bad trade. That was doubtless caused in a great measure by one of their principal industries—coal—being in a very depressed state. They all knew the difference in the trade of the town when the coal trade was brisk and when it was the opposite, and no one knew that better perhaps than the shopkeepers. Therefore, if the electric light were to be introduced now, the committee felt that it must of necessity prove—well, for a considerable time—a financial failure. They therefore recommended that for a brief period—not that they had any wish to throw aside altogether the adoption of the electric lighting of the town—they should postpone it until the committee and the Council might see fit to carry it forward. Those were the reasons principally upon which the committee based their conclusions. Mr. Woods seconded the motion, which was carried.

Eccles.—The General Purposes Committee reported at the Town Council meeting that they had received the following letter from the Board of Trade: "I am directed by the Board of Trade to state for the information of the Corporation that although the compulsory work under the order has not been executed within the time limited for that purpose, the order will not lapse until the Board have exercised their power of revocation. With regard to the request of the deputation from the Corporation who attended at these offices on the 7th inst., that the question of the revocation of the order should be deferred beyond the date fixed in the letter of this Department to June 1, I am to state that the Board will be prepared to consider a further postponement at or about the date referred to, but they are not disposed to bind themselves to postpone the question more than a year beyond the time already allowed. I am to add that should any application for a provisional order be made in the meantime by any company which could show that a substantial demand for the supply of electric force existed, and should the Corporation remain unwilling to put in force the power possessed by them under their order, it would devolve upon the Board of Trade to consider whether they would not revoke the existing order and grant an order to the company applying. In no case would the Board take any steps towards the revocation of the present order until the Corporation have had ample opportunity to make representations in the matter." A letter was also read from Mr. W. H. Bruce, of Manchester, stating that he was prepared on behalf of a London company to treat with the Council for the transfer of the order. The basis of such negotiation would be a saving of between £100 and £200 a year in the present cost of street-lighting, payment for the provisional order and the option of the Corporation to purchase the undertaking at any time. The Council decided to defer the whole consideration of the question of electric lighting until the January meeting in order to give any new members who may be returned in November an opportunity of expressing an opinion.

Hove.—The Works and Improvements Committee reported at the Urban District Council meeting that they had considered an application from the Hove Electric Lighting Company, and after an interview with Mr. Crompton, Mr. Reeves (secretary of the company), and Mr. Smith (manager) it was resolved that the Council be recommended to agree to a modification of the agreement with the electric lighting company so as to permit them to supply electric energy at a pressure not exceeding 220 volts at the consumers' terminals in new streets in which electric lines are hereafter laid, and to new consumers in streets in which electric lines are already laid, the modification to be expressed by deed to be prepared at the expense of the company, and due provision being made satisfactory to the committee enabling the Council to protect the interests of existing consumers. In moving the confirmation of the proceedings, Mr. J. Martin pointed out that the pressure under the present agreement was 110 volts, and that the company now wished to supply electric energy at a pressure not exceeding 220 volts. This increased pressure would only affect new

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customers, and the pressure for present customers would remain at 110, except any of them wished to change, in which case the company would be prepared to meet them liberally. Mr. Henriques did not quite understand how the present customers would be affected by the application of the electric lighting company, and asked the chairman of the committee for further information. It seemed to Mr. Leeney that the company was asking the Council for a favour, and he wanted to know if the Council would get a *quid pro quo*. The electric light was very dear in Hove, and he should have thought the committee would have endeavoured to secure a reduction to something like the price of the light in Brighton. Mr. Martin, replying to Mr. Henriques, said the company would deal liberally with all existing customers who preferred to have the higher voltage, and he had no doubt they would make the exchange themselves free of cost, or make an allowance With regard to the question of benefit to be derived, he informed Mr. Leeney that for the present there would be neither an advantage or a disadvantage, but ultimately there might be an advantage. The Chairman added that the company could not make any exchange of the voltage without the consent of the consumer. There was no difference in the cost.

Rathmines. — At the meeting of the Commissioners Mr. Edmondson moved the following resolution in pursuance of motion: "That before going further with the electric lighting scheme the opinion of Prof. Kennedy be obtained, and that the Electric Lighting Committee be instructed to take the legal steps in the matter." He said as they were about to spend £40,000 on the electric lighting of the township, they ought to go very carefully and cautiously in the matter. They had already got the opinion of Mr. Hammond, a gentleman against whom he did not wish to say a word, but, having regard to the large amount of money to be expended, it would be well to have a second opinion. He had been investigating the matter recently, and he had found that the most economic results in the way of electric lighting had been achieved in Edinburgh, where Prof. Kennedy was the specialist. He had also carried out electric lighting works in other parts of Scotland and England. He (Mr. Edmondson) would, however, be prepared to modify his resolution by not naming an engineer, but leaving that matter in the hands of the Board. Mr. Hewson seconded the motion and said Prof Kennedy seemed to have a record for cheapness and economy. The Chairman pointed out that the words of the resolution, "before going further with the electric lighting scheme," were not correct, as they had no scheme at present. They obtained a provisional order, but they had not settled on any scheme up to the present, and the matter was still in the hands of the special committee. Mr. Edmondson said they had got a preliminary advice from Mr. Hammond, and they had paid him £50 for that advice. Mr. Bolton did not at all agree with Mr. Edmondson's resolution, and considered it was very little short of bad taste for a member without consulting the committee to propose the name of a gentleman at that Board. Mr. Booth, as chairman of the Electric Lighting Committee, said they had as yet prepared no report; under the circumstances the resolution was a little premature. Mr. Hodgson thought they ought to be all deeply obliged to Mr. Edmondson for bringing the matter forward. Having regard to the fact that such a large sum as stated was to be expended, he thought a second opinion would be most valuable for the special committee to have before going further with the matter. Mr. Beckett was also of opinion that Mr. Edmondson should be thanked for his very valuable suggestions and for the way he had investigated the matter. After further discussion, it was agreed that, before any decision should be come to as to an electric lighting scheme, a second opinion should be obtained, the person to be selected to be considered at a future meeting of the Board.

Mitchelstown —At the meeting of the Board of Guardians the clerk reported that he had written to the Local Government Board as follows: "Sir,—I am directed by the Board of Guardians and the promoters of this scheme to state that they have had under consideration the enclosed circular of instructions from F. L. Warden-Stevens, Esq., in which it is stated that the cost of a license will be from £50 to £60, and the expenses to be incurred after in obtaining a provisional order will be from £200 to £300. This expenditure, if correct, seems to the Board of Guardians so enormous that it will be, as Mr. Webber states in enclosed letter, a prohibition to the carrying out of the scheme, and the Board will feel most thankful for replies to the following enquiries: The Mitchelstown Waterworks Provisional Order was carried though Parliament involving an expenditure of £5 500 at an outlay of £23—namely, local enquiry. £18; parliamentary agent, £5—all preliminaries being done by the clerk of union, and unless there is anything exceptional in the Lighting Act the Guardians in initiating the scheme were of opinion that a similar outlay or something near it would answer. If the license sought for will be granted, the Board propose lighting the town of Mitchelstown with 40 incandescent electric lamps, the motive power, a turbine wheel worked by water, wheel and water to be provided by the Countess of Kingston, of Mitchelstown Castle, who will make a contract with the Guardians to keep the light going for 22 years from sunset until midnight every night in the year. The Guardians are to supply all the plant and erect it save the turbine wheel and dynamo. The plant is to be the property of the Guardians, but to be kept in working condition by the Countess of Kingston for and during the term of contract for the sum of £70 per annum. The Guardians estimate that £500 will be required for the plant they must provide, and the annual instalment of this loan from the Board of Works for 35 years will be £30 The poundage rate on the area of charge now laid out will be 7d. per £ on a valuation of £3,349. The questions the Board are desirous of having answered: (1) probable expense of obtaining a license, the preliminaries to be done by the clerk of the union; (2) whether after obtaining the license it will be compulsory on the Guardians to obtain a provisional order; (3) whether there is anything exceptional in the way of expense in obtaining a provisional order under the Electric Lighting Act, and having it confirmed by Parliament to that in the case of order obtained two years ago for the Mitchelstown waterworks." The Local Government Board replied that the obtaining of a license under the Electric Lighting Act does not come under the jurisdiction of the Local Government Board—it is the Board of Trade who grant licenses and provisional orders. As regards a loan for the work the Board stated that (1) if under a license the time of repayment must not exceed the unexpired time of the license, and (2) if under a provisional order not more than 15 years for cables and not more than 25 years for other plant. The following notice of motion was given: "That the Guardians, for the purpose of complying with the procedure of the Electric Lighting Act, would, six months hence, consider a proposal to make application to the Local Government Board to grant a provisional order for the electric lighting of Mitchelstown, and that the amended area of charge for the scheme be readopted."

Torquay.—At the last meeting of the Town Council the Electric Lighting Committee recommended that the plans, general conditions, and specification of the works connected with the erection of municipal electricity works be approved, and advertisements issued inviting tenders for the supply and erection of the plant in accordance therewith. Alderman Kerswill formally moved the adoption of the recommendation. Alderman Mortimer, seconding, rejoiced to know that at last they were about to seriously take the scheme in hand. He had not the slightest doubt but that in the course of a year or two it would be a paying concern. He did not profess to be able to go minutely into the specification, but he had every confidence in the committee, and felt sure that in the hands of their able engineer everything would be carried through in a thoroughly able and up-to-date manner. Dr. Bunting showed that he had gone carefully through the specification, several details of which he criticised. He wished he could feel as certain as Mr. Mortimer that it would be a paying concern. Still, now the scheme was decided upon he should do his best for it, although he had not approved of it. Mr. Rockhey was glad to find that they had so able a critic as Dr. Bunting had proved himself. He remembered when they were discussing the electric lighting question it was suggested that they should proceed step by step in the carrying out of the scheme, and that the work should be carried out in a tentative way, and not the whole scheme at once. During the last two or three weeks he had been with a gentleman who was chairman of an electric lighting committee in a Midland town, and he strongly advised that Torquay should not go in for arc lamps for street lighting. These lamps were most expensive, and were found to draw very largely on their resources and cause a deficit on the annual working. The scheme provided for 70 arc lamps in Torquay streets. They should take warning by the mistakes of other places, and be advised that they make further enquiries about the matter. Alderman Harrison pointed out that no valid argument had been used against arc lamps, which were in general use everywhere. He had seen a great many of them, and they gave an excellent light. He did not see why they should hesitate about adopting the recommendation of their engineer, who must be fully aware of everything bearing on the scheme. The scheme had been thoroughly thrashed out, and every improvement had been adopted by the engineer. If they were going to have the electric light, let them have it and make the best of it. No good could result from referring back the question to the committee. Alderman Kerswell thought the arc lamps spoken of by Mr. Rockhey must be out of date. Mr. Smerdon said the earliest arc lamps used required almost daily attention, whereas those now used could burn for 140 hours without being attended to. Mr. Butland did not think they could do other than make enquiries, and the scheme would not suffer by a week's delay. Mr. Rockhey said Derby was the town he alluded to, and he believed the works there were of recent construction. The great want, apparently, was a good lamp. There was no lamp which answered the requirements, and the Derby committee was constantly going to their Council for extra sums to improve the lighting. Mr. Garrett suggested, and it was agreed, to insert a clause in the conditions giving the Council the right to make any alteration in the street-lighting. The motion was carried *nem. con.*

PROVISIONAL PATENTS, 1896.

OCTOBER 5.

22000. **Improvements in arc lamps employed in electric lighting.** John Henry Wheat and Arthur Wheat, 67, Blue Bell-hill, Nottingham.

22043. **Improved means applicable for use in working electric railways provided with underground conductors.** Adolf Hecker, 191, Fleet-street, London.

22046. **Improvements in electric switches.** Rookes Evelyn Bell Crompton and Edmund Arthur Norman Pochin, Arc Works, Chelmsford.

22061. **Converting direct electric currents into alternating currents.** David Cook, 30, Lancaster-park, Richmond, Surrey.

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22069. **Improvements in electric accumulators or storage batteries.** David Young, 11, Southampton-buildings, Chancery-lane, London (La Société Anonyme Accumulateur Eclair, Belgium)

22076. **Electric current director system for saving telephone and telegraph lines.** John Symons Endacott Ellis, 108, Pitt street Sydney, New South Wales. (Complete specification.)

OCTOBER 6.

22093. **Improvements in and connected with dynamos or electric generators, more especially to small machines where permanent magnets are used** James Henry Ward and Meyer Hart Goldstone, York street Electric Works, C-on-M., Manchester.

22102. **An electric lighting device for oil lamps** Hugh Donald Fitzpatrick, 70, Wellington-street. Glasgow. (Julius Eckel and Albert Glinicke, Germany.) (Complete specification.)

22127. **Improvements in electric locomotives** Henry Harris Lake, 45, Southampton-buildings Chancery-lane, London. (Louis Warfield United States) (Complete specification.)

22129. **Improvements in methods or processes for electro-thermally treating materials for the manufacture of calcium carbide and the reduction of metals from their oxides or other compounds.** Hudson Maxim, 45, Southampton-buildings, Chancery lane, London.

22144 **Improvements in electric or other motor trucks** The British Thomson-Houston Company, Limited 70, Chancery-lane, London. (Norman C. Bassett, United States) (Complete specification.)

22146 **Improvements relating to electric light and power circuits.** Edward Wingfield Bowles, 6, Bream's-buildings, Chancery lane, London.

22156 **A new or improved duplex electric switch** Philip F. W. Simon, 28, Southampton buildings, Chancery-lane, London. (Friederich Wilhelm Busch, Germany) (Complete specification.)

22167 **Improvements in or connected with electric incandescent lamps.** Cornelis Boudewijnse, 6, Lord-street, Liverpool.

22173 **Improvements in or relating to telephonic apparatus.** Philipp Johann Böse, 18 Buckingham street, Strand, London. (Complete specification)

OCTOBER 7.

22219. **A portable automatically-driven phonograph and graphophone suitable for commercial, domestic, and general use.** Ernest George Miles and Alfred William Turner, Cobden-buildings, Corporation-street, Birmingham.

22226. **An improved automatic electrical cut-out.** Henry John Wagg, 15, Great George street, Westminster, London.

OCTOBER 8.

22269. **An improvement in telephone switches (automatic).** William Wyld, 3, Clifton-street, Blackpool.

22282. **Improvements in ceiling roses for electric lamps** Christopher Thomas Briscoe and George Hedley Shaw, Penny Bank-chambers, Halifax.

22326 **Improvements in electric apparatus for lighting and extinguishing gas jets.** Gottfried Ferdinand Krieger, 22, Southampton-buildings, Chancery-lane, London.

22333 **A method of exciting synchronous or asynchronous dynamo-electric machines or motors working with alternating currents of constant potential.** John Imray, 28. Southampton-buildings, Chancery-lane. London. (La Société Anonyme pour la transmission de la force par l'electricité, France.)

22352. **Improvements in electric cables.** Henry Edmunds, 47, Lincoln's-inn-fields, London.

22353. **Improvements in apparatus for completing interrupting, diverting, and controlling electric currents.** Henry Edmunds, 47, Lincoln's-inn-fields, London.

22360. **An improved automatic telephonic exchange system** Salomon Berditschewsky-Apostoloff, 53, Chancery lane, London.

OCTOBER 9.

22402 **Improvements in switches for electric currents** William Robert Rawlings and John Joseph Rawlings, 82 Gloucester-road, South Kensington, London. (Complete specification.)

22416. **Improvements in and relating to the supports or holders of electric incandescent lamps.** Edward Prentice, 433, Strand, London.

22423 **An improved manufacture of electrodes for secondary voltaic batteries.** Ludwig Epstein, 28, Southampton-buildings, Chancery lane, London.

22442. **Improved means for electrically heating water and other liquids.** Robert E. Loesener, 18, Buckingham-street, Strand, London.

OCTOBER 10.

22464. **Improvements in electric switches.** James Marsden and Mark Pearson, 18, Southampton buildings, Chancery-lane, London.

22465. **Improvements in electric measuring instruments.** Arthur Wright, 111, Gloster-road, Brighton.

22513. **An improvement in telegraph cables and their connections.** James Mark Barr and Charles Edmund Stanley Phillips, 28, Southampton-buildings, Chancery-lane, London.

22520. **Improvements in phonographs.** Philipp von Wouwermans, Carl Kohn, Johann Kohn, and Theodor Fischer, 46, Lincoln's-inn fields, London.

22530. **Improved means for controlling and for effecting combinations in the stops of electro-pneumatic organs.** Arthur George Hill, 372, York-road, Camden-road, London.

22552. **Improvements in apparatus for electrically actuating the stopping mechanism of engines, motive power, or machinery in case of accident or otherwise, in part applicable to other purposes.** George Ernest Murray Stone, 217, Upper Thorpe, Sheffield.

SPECIFICATIONS PUBLISHED.

1894

23825*. **Arc lamps.** Brockie. (Amended.)

1895.

8210*. **Magnetic needles.** Gisborne. (Amended.)

9144 **Electric soldering apparatus.** Binswanger and Ball. (Amended)

15564 **Electric propulsion of vehicles or vessels.** Epstein.

18697 **Electric railways or electric transport.** Lorrain. (Esmond)

18822 **Mounting electric incandescence lamps for orchestral, reading, and like purposes.** Crawshaw and Bevis.

19669. **Secondary battery plates.** Schanschieff.

20828. **Primary electric batteries.** Rowbotham.

20925. **Primary and secondary batteries applicable for use with pocket electric lamps and for other purposes.** Burnet.

1896.

15074. **Electrically-ignited torches, cigar-lighters, or the like.** Hencken and Meyer.

16421 **Regulator for dynamo machines.** Heusch and Brandt.

17643. **Pocket electric lamp for use by surgeons and the like.** Smith and Green.

18273. **Dynamo-electric machines.** Lake. (Lundell and Johnson.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	8½-9
Brush Company, Ordinary	3	⅞-1⅛
—— Non. Cum., 6 per cent. Pref.	2	1⅛ 1⅜
—— 4½ per cent. Debenture Stock	100	110-113
Central London Railway, Ordinary	10	10-10½
——	2	4⅛-4⅜
Charing Cross and Strand	5	9½-10
Chelsea Electricity Company	5	7¾-8¼
—— 4½ per cent. Debentures	100	114-117
City of London, Ordinary	10	16-17
—— 6 per cent. Cumulative Pref.	10	17½-18½
—— 5 per cent. Debenture Stock	100	131-135
City and South London Railway, Consolidated Ordinary	100	50-52
—— 4 per cent. Debenture Stock	100	136-138
—— 5 per cent. Pref. Shares	10	14¾-15¼
County of London and Brush Provincial Co., Ordinary	10	8½-9
—— 6 per cent. Cum. Pref.	10	13¾ 14¼
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
Edison and Swan United Ordinary	3	1¾-2¼
—— 4½ per cent. Debentures	100	103-106
Electric Construction, Limited	2	1½-1¾
—— 7 per cent. Cumulative Pref.	2	2½-3
Elmore's Copper Depositing	2	½-¾
Elmore's Wire Company	2	¼-½
W. T. Henley's Telegraph Works, Ordinary	10	17½-18½
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	3¾-4¼
—— 7 per cent. Preference	5	8¾-9¼
India Rubber and Gutta Percha Works	10	22-23
—— 4½ per cent. Debentures	100	105-108
Kensington and Knightsbridge Ordinary	5	9½-10
—— 6 per cent. Pref.	5	8¼-8¾
Liverpool Electric Supply, Ordinary	5	8-8½
Liverpool Overhead Railway	10	13⅜-13⅞
—— 5 per cent. Pref.	10	17⅛-17⅝
—— 4 per cent. Mortgage Debentures of £100	100	112½-114½
London Electric Supply	5	⅞-1⅛
Metropolitan Electric Supply	10	12½-13½
—— 4½ per cent. First Mortgage Debenture Stock	100	121-124
National Telephone, Ordinary	5	7¼ 7½
—— 6 per cent. Cum. First Pref.	10	17-19
—— 6 per cent. Cum. Second Pref.	10	17-19
—— 5 per cent. Non. Cum. Third Pref.	5	6¾-7
—— 3½ per cent. Deb. Stock	100	106-109
Notting Hill Company	10	11½-12½
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8¼-8¾
—— £4½ shares	4½	7¼-7¾
Oriental Telephone and Electric Company	1	¾-⅞
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	103-106
Southampton Electric Company	5	4¾-5¼
St. James's and Pall Mall, Ordinary	5	11½-12½
—— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	39-42
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	—	7¾-8¼
Westminster Electric Supply, Ordinary	5	10½-11½
Yorkshire House-to-House		7½-8

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NOTES.

The Pacific Cable Scheme.—A telegram from Halifax, Nova Scotia, states that the Hon. Alfred G. Jones, formerly Minister of Militia, has accepted his appointment as Pacific Cable Commissioner, and will sail for England at once.

Telephones on the Continent.—The Brussels correspondent of the *Daily News* says recent trials between Antwerp and Berlin have been so far successful that the work of placing the two cities in direct telephonic communication will shortly be proceeded with.

Bad Light.—A lady has written to the *Times* to say that she has a boy at a public school, and that his eyes have gone wrong. An oculist was consulted, and put it down to a combination of small print and bad light, and added that "half the cases brought to his notice of children and young people are of the same class, combined with working in rooms insufficiently or badly lighted. Gas he strongly condemned."

Liverpool Engineering Society.—The opening meeting of the twenty-third session of this society will be held at the Liverpool Royal Institution on the evening of Wednesday, the 28th inst., at eight o'clock, when the president-elect, Mr. S. B. Cottrell, M.I.C.E., M.I.Mech.E., will deliver his inaugural address. The first of the fortnightly meetings is on November 11, and we hope to give a programme of the papers for the session next week.

American Telephones.—The contract of November 1, 1879, between the Western Union and American Bell Telephone Companies covering the use of certain patents will expire November 1, when all the patents embraced in the contract will run out. Under this contract the Western Union has received from the American Bell Telephone Company royalties amounting at one time as high as £120,000 per annum, but of late aggregating less than a quarter of that amount.

Physical Society.—A special general meeting of the Physical Society of London will take place at the rooms of the Chemical Society, Burlington House, at 5 p.m. on Friday, October 30, after which at an ordinary meeting there will be the following papers: (1) "A Satisfactory Method of Measuring Electrolytic Conductivity by Means of Continuous Currents," by Prof. W. Stroud and Mr. J. B. Henderson; (2) "A Telemetrical Spherometer and Focometer," by Prof. W. Stroud; (3) "An Experimental Exhibition," by R. Appleyard.

Telegraph Rates to India.—In a communication to the Liverpool Chamber of Commerce, the Postmaster-General regrets that his representations to the telegraph companies, in favour of a reduction in the rates to India, have been fruitless, in face of the great loss of revenue which would be involved. On the other hand, the companies have, it is stated, made reductions in the charges for telegrams to the Far East, particulars of which are to be announced. The rate for China will be reduced, it is said, from 7s. to 5s. 6d. per word.

Next Week.—Eastern Extension Telegraph Company's meeting is on Wednesday at Winchester House. The Brazilian Submarine Company's meeting is also at Winchester House on the same day. The opening meeting of the Liverpool Engineering Society takes place at Liverpool on the same day. There will be an Electro-Harmonic concert to-day week (October 30). The Physical Society meets on Friday, October 30, at 5 p.m.; particulars of the business are given in another note. There is a visit of the Junior Engineers to the Hotel Cecil on October 31 to inspect the electric lighting there.

Exhibitions.—A meeting has been held at the London Chamber of Commerce in support of the Vasco da Gama and Indian Celebration and Exhibition at Lisbon next year. Sir A. Rollit, M.P., president of the chamber, was in the chair, and many City firms were represented. In reference to the Brussels Exhibition of 1897, the report of the executive commissioner to the British Commission shows that already the minimum area acquired for the British section (3,000 square metres) seems likely to be secured by exhibitors of the first rank. Space in addition to the minimum area can be acquired, if necessity arises, before the end of the year.

Accident.—Dr. G. Danford Thomas has held an inquest at the Holborn Town Hall on the death of William Creighton, aged 36, a working foreman in the employ of Messrs. W. Scott and Co., the contractors engaged in constructing the Holborn Station of the Central London Electric Railway. Creighton was working at the bottom of a pit 80ft. deep. A skip laden with earth had just been raised when the rope broke, and the skip fell upon him and killed him. When the skip was raised the workmen below were told to stand clear, but deceased thought it was up and had resumed work. A verdict of accidental death was returned.

The Telephone Service.—The following is from the *Financial Times*: "The telephone men of Yorkshire are threatening a strike, owing to an inforced increase in working hours on the old standard of pay. The strike, we are told, may possibly assume a national character. On the whole, we receive the news with perfect equanimity. If the telephonists strike we shall be able to save time by the employment of messengers instead of wasting valuable hours by the pretence that the telephone is more expeditious." In Fifeshire they display an inclination to try if they cannot do things better than the combined result of the Government and the Telephone Company's efforts. In our City contemporary's office they apparently merely despair.

New Publication.—We have received the first number of the *Automotor and Horseless Vehicle Journal*. This is, or is to be, "a record and review of applied automatic locomotion." It is to come out monthly from 62, St. Martin's-lane, for the price of 6d. The present issue contains the text of the new Act, some illustrations of motor carriages, a portrait of Sir David Salomons, a great deal about the Paris-Marseilles race, and notes and other matter to make up 35 pages. As there cannot be very much to record and review just at present on the subject of motorcarts in this country, this is not a bad start. The only thing we dislike about our new contemporary is its name. Quite apart from questions of linguistic purity, people who have already got automaton in their memory will not easily say auto-motor, while as for "horseless vehicle," that is a periphrasis which covers, among other things, donkey-carts, bicycles, wheelbarrows, and bath-chairs.

Lightning Flashes.—About a month ago a very curious lightning flash, in which the course of the discharge was a spiral, was described by a correspondent of *Nature*. Mr. Benjamin Davies now writes saying that some years ago he witnessed what was probably a flash of the same kind. "In the early evening of a fine summer day," he says, "while sitting leisurely on a hedge on a comparatively high hill near to Llandyssul, in the county of Cardigan, with an immense area of country within reach of my vision, there appeared slightly above the horizon in the west what seemed to be a perfectly endless flash, almost circular in shape, and exceedingly serrated. There was not a single stray end to be seen, as in Mr. Burch's flash. I heard no thunder, and I knew from the faintness of the

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spark that it was at a great distance from me. This flash lasted for a longer time than any one I have seen since. I happened to be gazing at the actual spot when the flash occurred, and I saw it well."

Mischief.—At places where they entertain it is just as well to put the switches out of the reach of the public. This week at the Aberdeen Police Court, before Bailie Brown, John Simpson, apprentice cabinetmaker, Esslemont-avenue, was charged with having, while the Patti concert was proceeding in the music hall, on the 12th inst., turned off part of the electric current by which the buildings were lighted, to the danger and annoyance of the audience. He pleaded guilty. From a statement by the procurator-fiscal, Mr. Lamb, it appears that on the night in question accused had been at the hall with a companion. Accused suggested to the latter that he should turn off the light, but this the other lad refused to do, and accused thereupon proceeded himself to put his suggestion into execution by turning one of the electric knobs. The Bailie said the offence was a serious one, especially in a place where there was such a large crowd, and marked his sense of its serious nature by imposing a fine of half-a crown, with the alternative of 24 hours' imprisonment.

The German Association.—At this year's meeting of the German Association, which, unlike the British, includes medicine and surgery as well as natural science within its scope, the president was Prof. H. von Ziemssen. The meeting was at Frankfort-on-the-Main, and among those present at the opening was the Empress Frederick. There was practically no presidential address. In the physics section Prof. Quincke read a paper on rotation in a constant electric field, and there were contributions by Dr. Tuma on Ruhmkorff coils, by Prof. Nernst on contact electricity, and by Prof. Van 't Hoff on slow oxidation. Dr. Traube and Dr. Wiechert had contributions on the arrangement of the elements, and Dr. Karl Schaum on physical isomerism. There was a paper from Dr. Coehn on the electrochemistry of carbon compounds, and Prof. Lenard had a contribution on cathode rays. An immense amount of work was got through, and when it was over there came the visits and excursions, including one to the Darmstadt technical institute.

Motorcarts.—An exhibition of motorcars has been held at the Palais de l'Industrie, in Paris, and among the exhibits were the cars which have been recently run from Paris to Marseilles and back, a distance of over 1,000 miles. These still bear the marks of the journey, but the *Daily News* correspondent says that beyond damaged tyres, which are mostly of solid indiarubber, the distance and high rate of speed do not seem to have affected them. "Reckoning 10 hours to a day's run, the fastest performance was 66 hours for the double journey, accomplished by a phaeton to hold four." The vibration is complained of. As they were all petroleum cars, that is not wonderful. In this country the date for the Motorcar Club's run to Brighton has been again set back from the 24th inst. to Saturday, November 14, the date when the new Act comes into force, and between 30 and 40 motorcars are expected to meet at the London Metropole at 10.30 a.m. for the event. It is understood that the police were—arranged with, but that the Surrey County Council was obstructive up to the last.

Electro-Harmonic Society.—There will be a smoking concert on Friday, October 30, 1896, at the St. James's Hall Restaurant (Banquet-room), Regent-street, W., at eight o'clock. The following is the programme—Part. I.: violin, piano, and Mustel organ, "Largo" (Handel), Messrs. T. E. Gatehouse, Alfred E. Izard, and H. M. Higgs; song, "The Devout Lover" (M. V. White), Mr. Daniel Price; recitation, Mr. Charles Fry; pianoforte solo, "Tarantella" (Chaminade), Mr. Alfred E. Izard; hand shadows, Mr. David Devant; sacred song, "Ave Maria" (Gounod), Master Willie Gammage; humorous sketch, Mr. Walter Banks. Part II.: violin, piano, and Mustel organ, "Cantique de Noël" (Adam), Messrs. T. E. Gatehouse, Alfred E. Izard, and H. M. Higgs; song, "Molly Carew" (Constance Maud), Mr. Daniel Price; violin solo, "Three Songs Without Words" (Mendelssohn), Mr. T. E. Gatehouse; recitation, Mr. Charles Fry; Mustel organ solos, "Prière et Berceuse" and "Villageoise" (A. Guilmant), Mr. H. M. Higgs; song, "Killarney" (Balfe), Master W. Gammage; humorous sketch, Mr. Walter Banks. The musical directors are Mr. T. E. Gatehouse and Mr. A. E. Izard.

The Morse Alphabet.—The *Daily Telegraph* says: "It is good for the public that telegraph clerks are peculiarly anxious to clear themselves from the accusation of carelessness insinuated against them by the Bishop of Stepney and a 'North London Clergyman.' In addition to the letters of protest already published, a telegraphist writes from Paddington to point out the difficulties under which operators labour. 'Taking a fair average speed of 30 words per minute, we get 900 sounds per minute, or 54,000 per hour. Between each dot and dash there must be a space equal to one dot. Between the letters the space should equal two dots and between words three dots. Working at the above-mentioned speed the duration of each dot would be one-eighteenth of a second, the dash, being equal to three dots, would occupy one-sixth of a second. The difference then between a dot and a dash is equal to one-ninth of a second. This difference is so very slight that if a dot is in the least degree lengthened it would sound like a dash, and of course *vice versâ*. As an example, take the words 'boy' and 'box.' One of the dashes in the letter 'y' having been shortened by one-ninth of a second in duration becomes 'x.' Another example is 'dead' and 'bad,' where by spacing one-ninth of a second instead of one-eighteenth between the 'd' and 'e,' those letters become 'b' ('d' has one dash and two dots, 'e' one dot only, while 'b' has one dash and three dots). By taking the sense of the message many of those errors are avoided, but very frequently the senders, to save a halfpenny or two, cut down the message so that there is no sense in it for the telegraphist's guidance."

Electricity and the Farm.—One of the things that will never be understood is why usually sensible and careful papers should feel at liberty to print any nonsense if it is only stated to have occurred in America. The following is a "Note" in the *Newcastle Daily Chronicle*: "The connection between electricity and agriculture is becoming daily more intimate in the United States. According to the officials of the Washington Patent Office, inventors have turned their attention largely to the adaptation of electricity to farming, and have displayed so much industry and ingenuity that there is now no reason why a farm should not be worked entirely by electricity. Electric ploughs, harrows, drills, carts, reaping and binding machines, and even contrivances for forcing, are at the disposal of the husbandman. Several electric farms, so to speak of them, are already in existence. In the neighbourhood of Chicago power is derived from the river, and in the West a 15-blade plough, which will cut a furrow 6ft. wide, is also actuated by water. The blades revolve, and the plough is pulled across the field by means of a cable passing round the drum of an electric motor on the plough." Surely at Newcastle, if they have never seen a plough, they must have seen a furrow. We think that a plough hauling itself along a wire rope by means of an electric motor might work

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out a cheaper machine than the present steam-plough, which is hauled along by a moving rope, and all that has been done in the way of experimenting on the effects of the electric light and of earth currents in vegetation has received full attention in these columns. But the enterprising landowner that sends a commission to the States for "electric ploughs, harrows, drills, carts, reaping and binding machines" is likely to be disappointed.

Indiarubber.—It has been stated in the New York *Electrical World* that in America manufacturers and dealers in indiarubber goods are turning their attention to Southern Florida as a possible source of supply of the rubber, the increase in the consumption of which grows at a much quicker rate than the production. At the present time the electrical industries alone demand a greater supply than was used in the world's entire rubber industry a generation ago, and the necessity for new sources of supply is well understood in the trade, though no immediate anxiety is felt. Doubtless there is enough caoutchouc in the world to meet all the demands of the present generation. But the demand is increasing at a rate that is not realised except by the dealers and manufacturers. Of the present supply about two-thirds comes from Brazil. The other third comes from various parts of the tropical and sub-tropical world, and from time to time new fields are opened as the older ones are worked out. The trouble with Florida will probably prove to be, as usual, that the climate of that State is neither one thing nor the other—neither sub-tropical nor temperate. That is to say, that occasionally there are frosts there which are severe enough to affect orange trees.

The Junior Engineers.—The annual general meeting of the Institution of Junior Engineers was held at the Westminster Palace Hotel on Friday last, the retiring chairman, Mr. H. J. Young, presiding. There was a large attendance of members. The council's annual report, which was read by the secretary, Mr. Walter T. Dunn, showed that the total membership was now 454, an increase of 36 on the past year. Mr. A. R. Binnie, M.I.C.E., is the president for the ensuing sixteenth session. Seven meetings had been held for the reading and discussion of papers, and 11 visits to works had been made, at which the average attendance had been nearly 90. The summer meeting in Scotland had been highly successful. The report also contained a copy of the address of congratulation presented to Lord Kelvin, one of the institution's vice-presidents, on his professorial jubilee. Reference was made to the work carried on by Mr. H. Kempster as hon. librarian, and to the special course of lectures on marine-engine design by Mr. H. H. Rounthwaite, and the institution's first conversazione, the appointment of delegates to the Sanitary Congress, and the office fund, were other matters noticed in the report. The officers for the ensuing year were elected as follows: chairman, Mr. H. P. Varley; vice-chairman, Mr. Basil Joy; hon. librarian, Mr. H. Kempster; hon. auditors, Messrs. W. H. D'Ritter and P. Marshall; members of council, Messrs. Adam Hunter, E. Barry, K. Gray, Bertram Joy, A. Anstruther Thomson, G. F. Burtt, E. King, and Walter J. Hunter. The inaugural meeting of the sixteenth session will take place on November 6, when Mr. A. R. Binnie, M.I.C.E., will deliver his presidential address. There will be a visit of the members on Saturday, 31st October, at 3 p.m., to the Hotel Cecil, to inspect the electric lighting, hydraulic, warming, and other engineering features of that establishment.

Lord Rosebery on German Competition.—Lord Rosebery has been eating oysters at Colchester and opening a technical school there. As, in spite of recent events, he is a person who stands a chance of getting his views carried into effect, what he says is important. Lord Rosebery's speech is too long for reproduction here, but he began with a tale of an American: "The other day a young American gentleman came through the technical course in Germany. He was offered a considerable position in that country, but he preferred naturally, being an American, to live in England if possible, if in Europe at all, so he came over to England, and he was at once offered by a large firm a lucrative post. The firm told him, 'Oh, if we had many men like you, employment could be found for all of them; but what happens is this—we have not men possessing the technical and commercial education which is given abroad; we have to take foreigners to fill these posts, and the result is that foreigners learn our business, and go back, very properly and naturally, and practise it at home to our detriment, and as our rivals.'" His Lordship considered this an object lesson worth a ton of argument, and ended by urging an enquiry on the subject. "An exhaustive enquiry would not be long. The facts are all at your fingers' ends. They only need a very small amount of codification and further enquiry. I will take three men, one of whom is present with us to-day [Sir Courtenay Boyle was at Colchester], who can bring such an enquiry to an end in six months without spending £500 of public money. I say that Lord Farrar, Sir Philip Magnus, and Sir Courtenay Boyle could, without the slightest difficulty, produce all the facts bearing on this subject within six months. They have only to examine the consular reports, to obtain reports from leading merchants engaged in foreign trade, and to ask for the opinions of our Chamber of Commerce. If they do this, I will venture to say, without prejudging the case, that they would produce a compact and handy volume that would make all the hair of the public stand on end."

Aerial Navigation.—We have received some illustrations and a description of an "air ship" designed by Mr. C. Tziolkovsky. We need hardly add that the inventor is a Russian. As a large part of the description of the vessel is in Russian, and only a part is translated into French, it has not been so easy for us to follow the matter. The apparatus consists of two essential parts; one, the balloon giving the lifting power, and the other the car containing the motors. The balloon is of the orthodox cigar shape, but iron enters largely into its composition. It is some 220 yards long and 65 yards diameter. On the car a number of gas-engines are placed which are supplied with fuel from the balloon. The exhaust from these is passed out through a pipe, which is led through the balloon before reaching the atmosphere. The heat of this pipe causes the gas to expand, and thus to make up for the quantity abstracted for the engines. A by-pass valve allowing the products of combustion to escape direct into the air affords a means of regulating this heating effect. The inventor places the engines at different parts of the car, so as to get steering and elevating power. The balance of the car is also regulated by a small truck holding ballast. The whole idea seems most feasible if only the figures on the subject would be more in keeping with the desires of the inventor. We notice that the car is to take 70 passengers, and their weight is a comparatively small part (one-seventh) of the total weight. We then calculated the lifting power of the quantity of hydrogen gas said to be contained in the balloon, and do not find it to rise to the occasion. Of course, everything depends on the details in a case of this kind, and we are afraid that the details of the apparatus before us are yet to be successfully overcome. It is a pity that such should be the case, as the balance-sheet in the description shows that a profit of 500 per cent. per annum would accrue to

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the owner of the aerial omnibus. This is on the assumption of a regular traffic of 7,500 hours per annum. The mean speed is estimated at 25 miles per hour, and the charge per mile at 2½d.

An Electric Street-Sweeper. — The *Scientific American* publishes a large illustration of an electric self-loading car for sweeping up and carrying off the street refuse. The car is 8ft. wide by 25ft. long and 11ft. high. It is carried on two axles, and is fitted with the usual equipment of a trolley car. The brakes and the motor are placed above the wheels. The motor is connected by chain and sprocket gear to the driving wheels and to the brush, the brush making five revolutions to one of the car wheels. The brush runs in a cylindrical case which is open at the top and the bottom, and it is arranged to work both ways, a reversible steel deflector being arranged above the brush. The car consists of an upper platform, in the centre of which is a shelter or cab containing the motor, and a lower closed section, into which the street rubbish is thrown. Its lower floor is formed in parallel sections, which are hinged transversely to the car, and by the operation of a lever can be opened for dumping out the refuse. The broom, which ordinarily is the full width of the car, can be extended to cover nearly the full width of the street if so desired. In operation these cars are used in connection with manual labour, the sweepings of the gutters and sides of the street being thrown toward the centre, where they are picked up by the car, which thus sweeps its own section of the road, and also takes the place of the refuse carts. The car is the invention of A. Jackson Reynolds, of Montreal, who states that when sweeping it travels at the rate of six to eight miles an hour, and that it carries refuse, snow, etc., out of the city at a cost of 10s. per mile. For removing snow a car specially wide and long is constructed, and it is claimed that by running the car continuously during a snowstorm there is no difficulty in keeping a street open. A self-loading car is now being built, which will be one of the largest street cars in the world, being 8½ft. wide and 45ft. in length. It will have a capacity for cleaning 25 miles of street without stopping. We have before referred briefly to this invention, but the details given above have not hitherto been available.

A Western University.—We have received the *Catalogue* of the University of Wisconsin. Few things are more curious than the different ways in which the idea of a university finds expression in different countries. There is the cast-iron system of France, as compared with the German system, just at present so very much admired by all who know little about it. We have our own in England, which, like many English institutions, is unique, and totally and completely different ways of doing things in Scotland and Ireland. In the United States the function of establishing or chartering a university belongs to the State and not to the Federal Government. As there are 45 States, the limit of the centralised system there is fortunately the boundary of the State, and there are universities of all sorts. An English undergrad., for instance, would be tolerably puzzled as to the meaning of a "college" or "hall" at the Wisconsin University at Madison. Wisconsin looks big on the map, but when its population is remembered the long list of instructors and special lecturers, as given by the *Catalogue*, in the mechanics and physics department seems wonderful; but throughout the genius of the American nation is shown by the energy devoted to practical matters. The following relates to laboratory work: "For elementary instruction in the electrical laboratory, the electrical apparatus of the physics department is available. The electrical laboratory is also well supplied with exact scientific and commercial instruments, and is arranged for instruction and investigation. With the additional space and apparatus which is allowed through the generosity of past legislatures, the equipment has been made unusually complete in the lines of continuous current, and single and multiphase alternating current generation and distribution, and commercial electro-chemistry. The dynamos in the laboratory are arranged in a large special room, with a special engine of exceedingly close speed regulation. For use in testing dynamos, all necessary apparatus, including a Brackett cradle dynamometer, is at hand. A photometer-room is well arranged for the commercial comparisons of arc and incandescent lamps, or for scientific investigations."

A Retrospect.—In the course of the Huxley memorial lecture, delivered at Charing Cross Medical School by Prof. Michael Foster, the condition of things in the scientific world when Huxley was a student is compared with that at the present time. As the expression of testimony of a biologist to the educational value of physics, the following remarks of Prof. M. Foster have an importance outside their intrinsic interest: "At the present time the sciences of physics and chemistry have each of them developed into a body of logically co-ordinate truths, furnishing an instrument of peculiar value for the training of the scientific mind. Moreover, the methods of teaching have developed in no less a degree, so that in the laboratory the student follows, at a long distance, it is true, but still follows the steps of those who have made the science, and has at least the opportunity of catching something of the spirit of scientific enquiry. In this educational value of these sciences, even more than in the practical utility of a knowledge of the mere facts of the sciences, great as that may be, lies the justification of the authorities when these, desiring to improve the profession by introducing artificial selection into the struggle for existence, insist that all to whom the lives and health of their fellow-men are to be entrusted should have learnt at least something of the sciences in question. In the time of Huxley's studentship both these sciences were in a very different condition. The time, it is true, was one of great awakening. In physics men's minds were busy opening up the hidden powers of electricity; some 10 years before Faraday had made an epoch by discovering induced currents; he and others were still rapidly extending our knowledge, one practical outcome of which was the introduction of the telegraph in 1837. But how great has been the onward sweep in electric science since then; how great the advance in all branches of physics! To realise the great gap which separates the physics of to-day from the physics of then one has only to call to mind that the world had yet to wait some years before Mayer, and Joule, and Helmholtz, and Grove had said their say; in the books which taught young Huxley the laws of physics he found not a word of that great law of the conservation of energy, which like a lamp now guides the feet of every physical enquirer, whatever be the special path along which he treads."

Acetylene Explosion. — The early workers with acetylene always considered it a dangerous gas, especially when under pressure, but it has been supposed lately that the danger was over-estimated. At Paris last Saturday there was an explosion on the slope of Montmartre in a building where for two months Mr. Raoul Pictet, the Geneva chemist, has been manufacturing acetylene. One of the steel tubes, 3ft. long, used for storing the gas, exploded. It was the dinner-hour, and only three workmen were on the premises at the time. The accident caused for some moments a panic in the district, as people

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thought that a dynamite explosion had occurred, and rushed about the streets seeking to escape from what they regarded as a catastrophe which was to have widespread consequences. When the police entered the Pictet establishment, they found that the whole frontage of the place had been blown out. The headless trunk of one workman, Pierre Pautre, was discovered buried beneath a mass of broken glass and rubbish. Not far away from an intact gasometer was the carbonised corpse of Léon Secret, another person employed by Mr. Pictet. It has been ascertained from the fragments that the tube which exploded, and which was practically full, was returned from Brussels on the 13th inst. along with 74 empty ones. It is suggested that the workman either held a lamp near it or was unscrewing the stopper with such force as to produce heat, but nothing is really known. In another part of the premises were 30 tubes, each containing 26 gallons of acetylene, as also two large reservoirs, one containing 5,000 gallons. It seems difficult to account for the extreme violence of the explosion. It has been suggested that acetylene might explode on detonation even when quite unmixed with air, but it will be noticed that in this case the explosion did not spread. Negative evidence of that kind, however, is not of much account. According to researches on the explosive properties of acetylene by MM. Berthelot and Vieille, communicated to the Paris Academy of Science, in which details were given of experiments carried out with a view of seeing what precautions (if any) are necessary in the preparation, compression, and storage of acetylene for commercial uses, the decomposition of acetylene by a heated wire, by mercury fulminate, or by the electric spark, is not propagated any considerable distance if the gas is under atmospheric pressure. At pressures of two atmospheres and over, however, the decomposition is complete, the explosive pressure produced rising so rapidly with the initial compression, that the effects produced by detonation of the liquefied gas resemble those of ordinary explosives.

Technical Instruction Abroad.—The annual meeting of the Leicester Technical Schools was the occasion of an address delivered by Mr. W. Woodall, M.P., one of the members of the Royal Commission on Technical Education. Mr. Woodall, with certain of his old colleagues, has recently paid an unofficial visit to Wurtemberg and Bavaria. In the course of his speech, Mr. Woodall made some interesting remarks with reference to the Stuttgart Polytechnic and the Schuckert works. At Stuttgart in 1884 the polytechnic had been enlarged at a cost of £75,000, and included departments for chemistry, physics, and architecture. But since that time, in deference to the urgent demand, imposing buildings had been erected for special and separate instruction in electricity, chemistry, and for building. Each of these cost about £50,000 for erection and as much more for equipment. The Industrial Museum was a noble edifice, recently erected at a cost of £200,000, modelled on South Kensington, and completed and furnished admirably. The Stuttgart Electrical Exhibition this year had shown how marvellously in a State that had no coal mines electricity had been made applicable for motive power, for lighting, and cooking, and new industries of every kind were being rapidly developed even in the remoter mountain districts. But it was at Nuremberg that electrical science had found its most profitable application. The Schuckert factory employed 3,500 hands. It had grown from modest beginnings to its present proportions within 20 years. It undertook to provide installations for railways, tramways, and lighting in all parts of the world, but was only one of the great electrical enterprises that in modern days had been developed in Germany. Schuckert's factory was administered by a large staff of highly-cultivated superintendents, everyone of whom had gone through a course of training in one of the German technical institutes. Mr. Woodall's contention was that it was to the intellectual and technical capacity of the employer class and the chief superintendents engaged in the administrative direction of the new factories in Germany that their economic and commercial success was most attributable. After the usual advocacy of everybody knowing two or three or more foreign languages (even an electrical engineer cannot know everything), Mr. Woodall concluded with the somewhat dismal prophecy that in the application of electrical science in all parts of the world to multifarious uses we in England shall have to put forward energies of which there are no present sign if we are to maintain a position side by side with, not to speak of precedence over, our American and Continental competitors.

Inventions.—Writing in *Electrical Engineering* (Chicago), Mr. Fred De Land makes the following most mysterious and oracular remark: "The successful demonstration of the utility and commercial value of an ingenious protective device, the general introduction of which will probably render obsolete the product heretofore turned out by a great industry, and completely revolutionise existing methods of construction, affords a golden opportunity to further destroy confidence in electrical investments, and incidentally to line the pockets of the legal fraternity." We do not in the least know what particular protective device this refers to, but Mr. De Land then continues to make certain observations on inventions and patents in general, and American patent law in particular. "The moment," he says, "the solution of the problem is made plain those who did not see it seek to belittle the achievement of the one man who did see it by the assertion that it was so exceedingly obvious and simple as to exclude the possibility of a demand upon the inventive faculties. This will not do. An invention does not cease to be meritorious because it is simple. Many of the greatest inventions are most simple. The test should be, not whether the mechanism is simple or complex, but whether the patentee has given the world something new; whether the public is richer for his contribution to the art; whether he has produced novel and beneficial results." And this recalls Mr. Lockwood's apt and witty answer in a certain infringement suit: "Little further comment is required, but it may be added that the same line of reasoning which was adopted by Mr. Expert in discussing that patent is available to prove that the electromagnet as it left the hands of its great inventor, Prof. Henry, is a complete anticipation of the dynamo-electric machine, invented many years thereafter; and adopting such reasoning, we may say that by extending the core of the said electromagnet at both ends, turning the same into journals, providing bearings wherein the said journals shall revolve, and by placing the magnet so altered between the poles of a horseshoe permanent magnet or electromagnet, and then by mounting a pulley or a crank on one end of the core of the first magnet, and by connecting its coils in the desired way, with the coils of the electromagnet between whose poles the first magnet is placed, we thus have a complete anticipation of the invention of the dynamo. And it is not difficult to prove in the same logical manner that a boa constrictor is exactly the same thing as an elephant; for it may with a good show of reason be said that by simply cutting off 12ft. of the serpent's tail and sewing it on to his head, and by providing him with four legs and a new tail, and by giving him a pair of tusks and fitting him internally to eat grass and hay, we thus have a complete anticipation of the elephant."

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THE PRINCIPLES OF ALTERNATE-CURRENT WORKING.*

BY ALFRED HAY, B.Sc.(EDIN.), A.I.E.E.

(Continued from page 427.)

79. One of the most striking and important points of difference between continuous and alternating currents lies in the fact that whereas the former will only flow in a circuit which is wholly conducting, the latter will, on the other hand, flow in a circuit part of which is composed entirely of non-conducting material. The ability of an alternating current to traverse insulators gives rise to some interesting and somewhat complicated effects; many of these are usefully applied in practice. In considering effects of this nature, we have to deal with a class of phenomena which are entirely absent in the case of continuous currents.

80. The student who has been mainly concerned with the study of continuous-current phenomena will at this stage have to endeavour and enlarge the somewhat limited and one-sided views of matters electrical which such a study is apt to engender. He must learn to think of alternating currents as passing not only through conductors, but through such bodies as bits of glass or guttapercha, oils, air spaces, etc.—*i.e.*, through insulators or *dielectrics*—without destroying them or altering their nature; and to remember that in all such cases the current produces precisely the same *magnetic effect* as that which is characteristic of it when flowing in a conductor.

The mechanism by which a current is conveyed along a conductor—whatever the ultimate nature of that mechanism may be—is different from that by which it passes through a dielectric. In order to distinguish between the two modes of conduction, it is usual to refer to currents passing along conductors as *conduction currents*; the varying currents which are capable of traversing a dielectric being termed *displacement currents*. These terms are convenient, but the student must be warned against the notion that there are *two kinds* of current which differ from each other in their effects; a conduction current is in every way similar to, and produces the same effects as, a displacement current, and the two terms merely relate to the nature of the medium through which the (same) current passes.

Probably the best method of introducing the student to the study of displacement currents is to have recourse to a very rough but useful hydraulic analogy. This is accordingly the method which we shall follow in dealing with the subject.

81. In Fig. 59 let P A B represent a circular closed pipe, inside which is a piston P which fits it exactly, and which is capable of sliding freely inside the pipe. We shall suppose the pipe to be completely filled up with a viscous incompressible liquid. If the piston, P, be caused to move round the pipe, a flow of the liquid will take place in the pipe, and this flow will be due to the difference of pressure on the two sides of the piston. If we suppose the liquid to be initially at rest, and a steady force to be applied to the piston, then, owing to the inertia due to the mass of the liquid, the velocity will increase gradually until a steady flow is produced. While the flow is variable the force driving the piston does work in two ways: (1) by imparting kinetic energy to the moving mass of liquid; (2) by overcoming the resistance to motion which is due to the viscosity of the liquid. The first portion of the energy is stored up; the second is dissipated in producing heat. When the flow has become steady no further storage of energy takes place; the whole of the energy supplied is now being dissipated in the form of heat. The rate of flow (which is measured by the quantity of liquid that flows past any cross-section of the tube in unit of time) which results for a given driving force applied to the piston will depend on the resistance offered to the motion by the viscosity of the liquid; a less viscous liquid will attain a greater velocity than a more viscous one. Let us suppose that after the flow has been going on for some time the steady force propelling the piston is suddenly removed. Owing to the inertia of the liquid, the flow will not cease suddenly but will go on for a time, the liquid pushing the piston in front of it. The force propelling the piston is now derived, not from any external source, but from the kinetic energy stored up in the moving liquid. Since no further supply of energy takes place, it is evident that the motion will gradually subside, the kinetic energy of the liquid taking the form of heat.

82. For the pipe enclosing the liquid substitute a closed conducting circuit, for the piston a source of E.M.F., and we get a rough and very imperfect, but nevertheless useful, method of picturing to our minds the actions which are involved in starting, maintaining, and stopping a current in a circuit. The rate of flow of the liquid corresponds to the current, the viscosity of the liquid to the resistance of the circuit, the mass of the liquid to the inductance of the circuit. The energy stored up in the moving liquid corresponds to that stored up in the magnetic field produced by the current. In each case, while the flow lasts, we have the transformation of energy into heat.

83. As we shall pursue this analogy somewhat further, and apply it to the case of a circuit a portion of which consists of non-conducting material, it will be necessary once more to warn the student against the notion that the analogy is intended to represent the actual mechanism of conduction. Analogies are very useful if not abused and mistaken for the actual systems which they are intended to illustrate; but if pressed too far, they may become sources of danger, and give rise to utterly erroneous ideas. In order to show the student how imperfect our analogy is, and thus put him on his guard, we shall draw his attention to one important

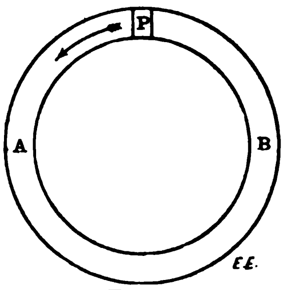

FIG 59.

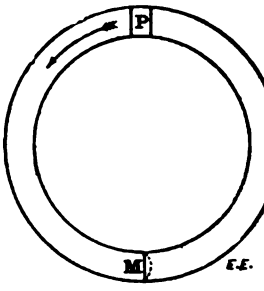

FIG. 60.

matter in which our hydraulic analogy signally fails. The kinetic energy of the moving liquid has its seat in the liquid itself, so that the energy is contained within the pipe. But in the case of an electric circuit, we know that in most instances the magnetic field spreads out into the surrounding space, and the bulk of the stored energy will have its seat not in the conductor itself, but in the space surrounding it (or, more correctly, in the *ether* which fills that space).*

84. Instead of the simple pipe shown in Fig. 59, let us next suppose that we have a similar pipe, but furnished with an elastic membrane, M (Fig. 60), which does not allow any flow of liquid to take place across it. Such a membrane would correspond to an insulator interposed between the two ends of a conducting circuit. If we suppose that the membrane is strong enough to resist any pressures which may be brought to bear upon it, then it is obvious that no continuous flow can take place in such a circuit. But since we have supposed the membrane to be elastic, it follows that if a force be applied to the piston, P, the pressure will be transmitted through the liquid in the direction of the arrow, and this pressure acting on the elastic membrane, M, will cause the latter to bulge (as shown by the dotted line), so that a *temporary* flow of the liquid will take place. Imagine the pressure to be gradually increased. The membrane will bulge more and more, and

* Based on a series of evening lectures delivered at the University College, Liverpool.

* Another important point on which the hydraulic analogy is misleading is the following. According to this analogy, the phenomenon of an electric current consists of actions which go on entirely inside the conductor; whereas according to modern views the most important actions which constitute an electric current take place *outside* the conducting circuit. The current is supposed to consist in the motion of tubes of electrostatic induction which, starting from the source of E.M.F., sweep across the space bounded by the circuit, the ends of the tubes gliding along the surface of the conductor, until the tubes enter the conductor, and thus become dissolved or destroyed.

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the *state of strain* produced in it will increase, until when a certain pressure is reached the membrane gives way, being ruptured; when rupture of the membrane has taken place, a steady flow becomes possible.

Returning now to the electrical case, let us suppose that we have a source of E.M.F., P (Fig. 61), connected to an arrangement, M, of two conductors separated by a dielectric; such an arrangement is generally called a *condenser*. When the E.M.F. is first introduced into the circuit there is some sort of elastic yielding of the dielectric which corresponds to the elastic yielding of the membrane in the hydraulic analogy. This yielding of the dielectric constitutes a *displacement current*. During the yielding a certain *quantity* of electricity (so called) passes into the condenser; this corresponds to the quantity of liquid which fills the space rendered vacant by the bulging of the membrane, M (Fig. 60). If the E.M.F. is gradually increased the strain in the dielectric will increase in proportion, until ultimately the material breaks down, a spark passing through it; thus an *arc* is established between the two conductors, through which a continuous current now becomes possible.

85. The quantity of electricity which passes into a condenser when a P.D. is established between its terminals depends on the amount of elastic yield in the dielectric, and this latter quantity is in direct proportion to the applied P.D. Hence we may write

$$\text{quantity} = C \times \text{P.D.},$$

where C is a certain constant quantity independent of the P.D. This constant quantity is termed the *capacity* of

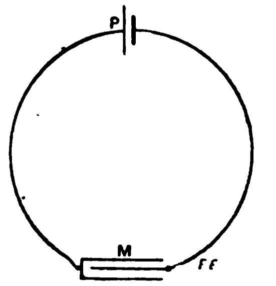

Fig. 61.

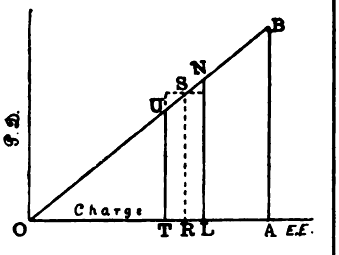

Fig. 62.

the condenser. If Q, C, and V stand for the quantity, capacity, and P.D. of a condenser respectively, then the relation connecting these quantities is

$$Q = C \times V.$$

Since, when $Q = 1$ and $V = 1$, C is also equal to 1, it follows that a condenser of unit capacity is one which is charged to unit P.D. by unit quantity.

The practical unit of capacity is the *farad*, and it is defined as the capacity of a condenser which is charged to a P.D. of one volt by a quantity of one coulomb. For practical purposes the farad is too large a unit, and it is usual to express capacities in terms of the *microfarad*, which is one-millionth of a farad.

It is not difficult to deduce an expression for the amount of energy stored up in a condenser. The relation between the quantity and P.D. is represented by a straight line, such as O B in Fig. 62. Let us suppose that the condenser is charged to a P.D. of V C.G.S. units by a quantity of Q units (C.G.S.). If O A in Fig. 62 is made equal to Q, and A B to V, then C, the capacity of the condenser, is equal to $\frac{Q}{V} = \frac{OA}{AB}$. Let us suppose that at a certain stage during the charging the quantity is O T, the corresponding P.D. being T U; and let us calculate the work done in increasing the charge by a small amount T L. While a quantity T L is being introduced into the condenser, the P.D. rises from T U to L N, and its mean value between these limits is R S (T R being equal to R L). Now it follows from the definition of potential that in transferring T L units of quantity against a P.D. of R S units an amount of work is done which is represented by T L × R S. But the latter product represents the area of the strip T U N L. Hence, the work in ergs done in increasing the charge by an amount T L is represented by the area of the strip T U N L. Applying this result to each successive increment of the charge, we see that the total amount of energy stored up in the condenser is represented by the area of the triangle O A B, and hence is equal to $\frac{1}{2}$ O A × A B—*i.e.*, to $\frac{1}{2}QV$. This result may also be written in either of the forms $\frac{1}{2}CV^2$ or $\frac{1}{2}\frac{Q^2}{C}$.

86. Returning to Fig. 60, let us suppose in the first place that the liquid used is an extremely viscous one, offering a considerable resistance to motion. On applying a force to the piston, P, the liquid is caused to flow slowly, distorting the membrane, M, until the latter takes up a certain permanent position, depending on the difference of pressure on its two sides. Translated into the electrical case, this means that when a condenser is charged through a very high resistance the charging current is unidirectional. Suppose, in the second place, that we have a liquid of very high density—*i.e.*, possessing considerable *mass* per unit volume—which is extremely mobile. If a constant force is suddenly applied to the piston, P, the liquid will be gradually set in motion, a (positive) flow taking place while the membrane is being distorted. But owing to the considerable inertia and absence of internal friction the liquid will *tend to move on* after the membrane has taken up its equilibrium position. Hence the membrane will overshoot its mark, and a series of to-and-fro oscillations will take place, the flow of the liquid taking place in alternate directions and with gradually diminishing amplitude, until the whole of the kinetic energy has become dissipated, and the membrane taken up its position of permanent distortion. The less the viscosity of the liquid the longer will be the time throughout which these oscillations persist. It is also evident that while the oscillations are going on the difference of pressure on the two sides of the membrane alternates between values which are successively above and below that reached when a permanent distortion of the membrane has set it. Translating once more into the electrical case we find that if a condenser is charged through a circuit of high inductance and very low resistance the charging current is not unidirectional, but *alternating*, with gradually diminishing amplitude; and the P.D. at the condenser terminals undergoes oscillations, rising above and falling below the E.M.F. of the charging battery.

87. Although the occurrence of certain actions in the hydraulic analogy is *no proof* that similar effects must occur in the electrical case, yet we may reason from the better known to the less known, and then leave it for direct experiment to decide whether the analogy has been pushed beyond legitimate limits or not. In the case under consideration experiment has shown that our deductions are correct for the electrical case; that under certain conditions oscillations such as we have been considering actually do take place.

When the time-current curve for an oscillatory charge is determined it is found to consist of positive and negative half-waves of gradually diminishing amplitude (but the same period), so that the area of each positive half-wave exceeds that of the succeeding negative half-wave, and therefore a certain quantity of electricity enters the condenser after each complete wave. The excess of the areas of the positive over those of the negative half-waves measures the charge (or quantity of electricity) in the condenser.

Since the P.D. at the condenser terminals during an oscillatory charge rises periodically to values in excess of the charging E.M.F., it follows that a condenser which is strong enough to stand a unidirectional charge from a given source of E.M.F. might break down with the same E.M.F. if the conditions of the circuit are such as to produce oscillations.

What has been said with regard to the *charging* of a condenser applies also to its *discharge*, and under certain conditions the discharge of a condenser becomes oscillatory.

From the explanations given above it follows that although, so long as the elastic membrane remains intact, no *steady flow* can take place in a system such as that shown in Fig. 60, yet if the pressure on the two sides of the piston in Fig. 60, and the E.M.F. in Fig. 61, be made to alternate, the elastic membrane in the one case and the condenser in

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the other *will respond* to the *alternating* pressure, and we thus see that an alternating (displacement) current is capable of passing through a dielectric.

88. In our hydraulic analogy, the rate of flow at any instant is measured by the quantity of liquid passing per second through any cross-section of the circuit. In the electrical case, the current at any instant is measured by the rate at which "quantity of electricity" is being transferred through any cross-section of the circuit. But the quantity which is so transferred passes into the condenser. Hence *the current is measured by the rate of change* (*Art 5*) *of the quantity in the condenser.* This result we shall frequently have to make use of in what follows.

(To be continued.)

RAILWAY BLOCK SIGNALLING.

BY J. PIGG.

(Continued from page 429.)

Fig. 76 represents a portion of the main line of one of the through routes to the North. Two important lines

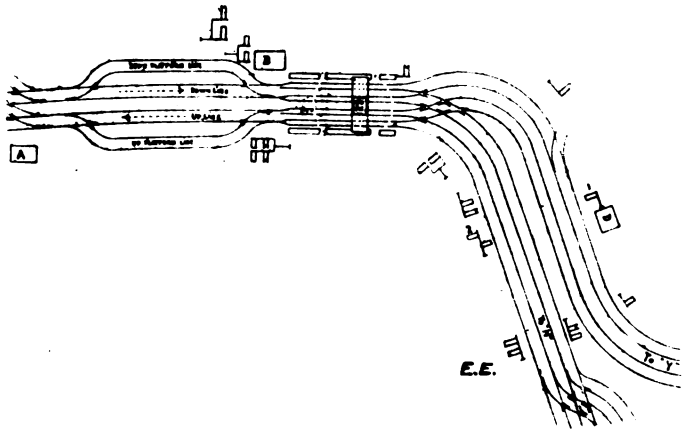

FIG. 76.

from the north and east converge upon a swingbridge crossing a navigable river. All four sets of rails are carried over the swingbridge, but the two "up lines" and the two "down lines" are "bunched," and the bridge is little wider than would be required for the ordinary double line of rails. At the south end of the bridge the lines widen again owing to the station platform lines being distinct from the running lines. Consideration of Fig. 76 will show the necessity for extra precautions in working this section of line, owing to the possibility of accident resulting from the fouling of the lines at the north end of the bridge, and from the presence of the bridge itself.

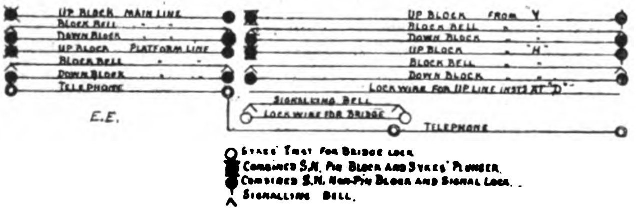

FIG. 77.

This portion of line is divided into two block sections, A B and B D (Fig. 76); C is a cabin on the swing portion of the bridge in which is installed the control of the hydraulic machinery for operating the bridge for the passage of river traffic, but although it is provided with electrical apparatus, connected with B, by which the operation of the bridge is controlled, it is entirely dissociated from the block working of the section B D, in which it is situated. The signalman at B is in this case the person controlling the operation of all traffic on to the bridge from either direction; and he also controls indirectly the river traffic by means of the apparatus by which the bridge is locked in the position for the passage of railway traffic.

The line is worked by three-wire single-needle block instruments, to which is added an adaptation of Sykes's lock and block to the indicators for the two up lines between D and B. The operation of the bridge is controlled by Sykes's instruments also, and the handles of the two down-line instruments are connected with the signal locking at B.

Fig. 77 is a diagram showing the wires used for signalling and locking between A and B, B and D, and B and C. The construction of the up-line block instruments at B, working to D, is shown by Fig. 78, and the additional apparatus to the corresponding instruments at D is shown by Fig. 79. So far as the block instruments themselves are concerned, they differ in no way from others previously shown, and the novelty of the arrangement consists in the addition of the lock bars, M *n* O, the continuation of the lever, L, and the plunger, P (Figs. 69, 70, 71), for specific purposes. Practically, the apparatus shown by Fig. 68 is split into its two component parts, the plunger and its locking apparatus being added to the "up" line instruments at B, and the signal locking, or receiving portion of the complete instrument, consisting of the polarised electro-magnet, armature, etc., being added to the corresponding

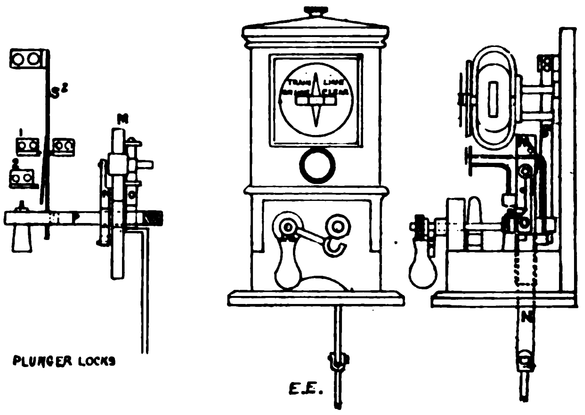

FIG 78.—S.N. Instrument with Sykes' Plungers.

instrument at D. The special bridge locking apparatus is shown by Fig. 80, the arrangement of apparatus at C being identical with those at B. The apparatus is practically the same as is shown by Fig. 68, with the exception that S^1 and the other connections for the semaphore indicator are omitted as the latter is not

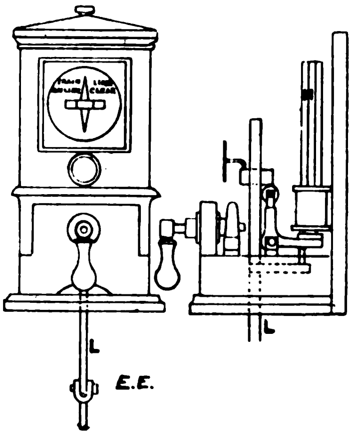

FIG. 79.—S.N. Instrument with Sykes' Signal-Locking Apparatus.

used. The handle of the switch, T (Figs. 69 and 71), is retained, but it is merely mechanical in the present arrangement. The general arrangement of the instruments at B relatively to the signal levers working the signals, points, clearance bars, and inter-cabin control is shown by Fig. 81, together with the interlocking of the "down" line instruments to A with the lever locking. Fig. 82 shows the electrical connections for the locking apparatus between B and C and B and D. The connections of the block instruments are not given, for reasons already adduced. It will be observed that the locking and indicating apparatus of

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the additions to the up-line block instruments at B and D are operated by one lever instead of by two, as in the ordinary arrangement of Sykes's instruments for block working, and this of course follows from the separation of the different parts. The levers, N, operating the plunger locks at B are connected together, as shown diagrammatically in Fig. 81, so that only one plunger can be used at once. The plunger of either instrument can only be depressed *after* the lever operating the rod, N, of that instrument has been moved into position for a train to approach on that line, and as this

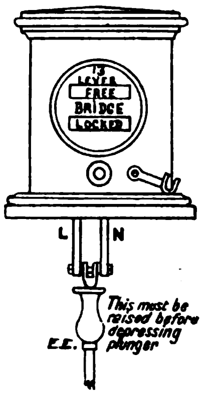

FIG. 80.—Bridge-Locking Apparatus.

lever is interlocked mechanically with other levers necessary to that particular line, it follows that the road must be completely set at B before either of the electrical locks at D can be released, and even then only the lock controlling the signal for one particular line can be released.

The signals 1 2 (Fig. 76) at D are those which are under electrical control from B. The levers, at D, working these signals are also connected, so that the operation of the lever for one of them locks the rod, L, of the other instrument, so that it cannot be released by a current from however sent. This is an additional check from against fouling at the north end of the bridge, and is quite independent of

B controls the down-line signals at A by lever 15 (Fig. 81), and this lever is interlocked with the handle, M_1, which, when placed vertical, causes the down-line instruments at A and B to indicate "Train on line." Hence, so long as the mechanical signals are obeyed, the bridge is protected against the approach of trains from A on the "down" line.

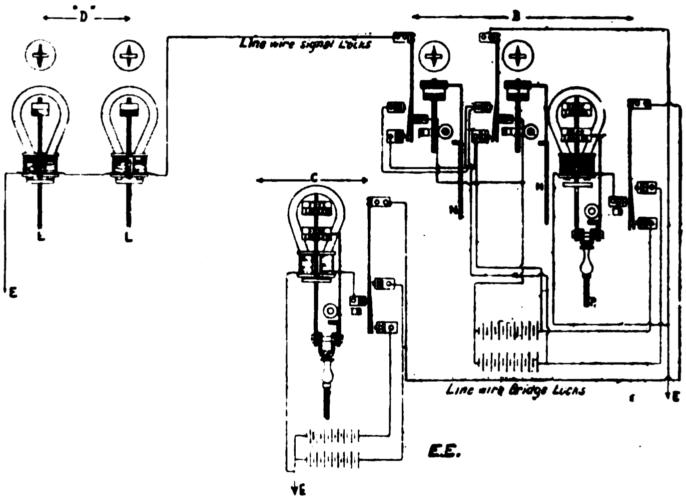

FIG. 82.

When it is necessary for the bridge to be opened for river traffic, C notifies B by the code arranged for use with the separate bell circuit. When the latter is ready, after performing the operations indicated for the protection of the down line, etc., he operates the bridge lock lever (13, Fig. 81) and raises the lever, P_1, by hand, and by depressing the plunger unlocks the instrument at C, enabling him to make the preliminary arrangements for opening the bridge. C then raises the rod, P_1, of his own instrument, and by depressing the plunger locks the lever 13 at B in the open position, and thus prevents it being inadvertently put back. Under these conditions C is master of the situation, and

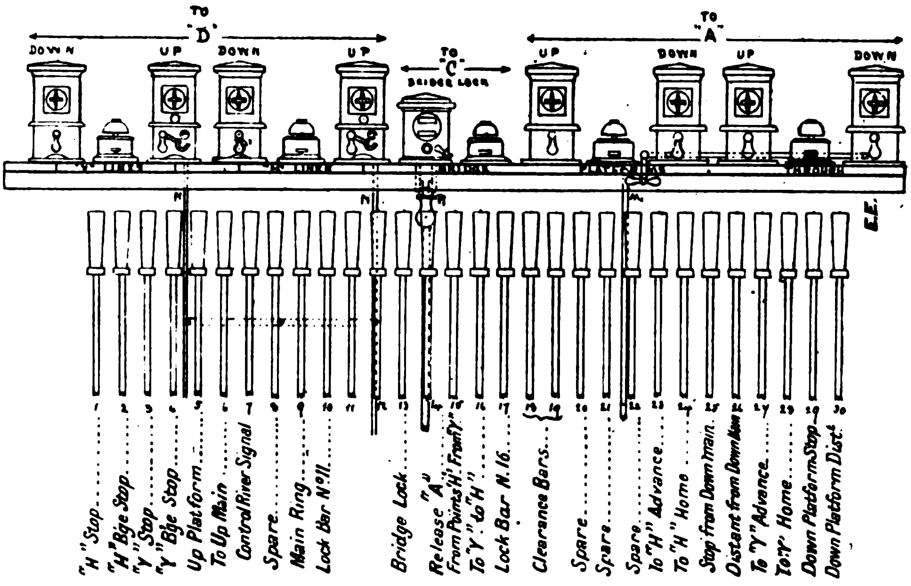

FIG. 81.

the action of the plunger locks and the connection existing between the two rods, N and B.

As will be seen, B effectually controls the approach of trains from D, and so long as the apparatus is in order and the mechanical signals are obeyed it is impossible for trains to foul each other at the north end of the bridge. Fouling between a train passing from B on the "H" line and a train approaching B on the "Y" line is provided against by the mechanical interlocking of the signal and point levers.

In addition to the provisions described for ordinary working over the "bunched" part of the block section, B D, provision has to be made for blocking all four lines from both directions during the time the bridge is open for river traffic. The up lines from D to B have been described.

B is unable to undertake any operation involving the approach of trains from either A or D. When the bridge is again ready for railway traffic the operations are reversed, and C becomes dependent again upon B for permission to operate the bridge on the succeeding occasion.

(To be continued.)

A Bright Magazine.—We are in receipt of a copy of the *English Illustrated Magazine* for November. In this number, as in previous ones, a marvellous amount of interesting reading matter is given for the humble sixpence, and it is, moreover, sufficiently varied in character to please all readers. The numerous illustrations are also very well executed.

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COMPARISON AND REDUCTION OF MAGNETIC OBSERVATIONS.

Report of the Committee, consisting of Prof. W. G. Adams (*Chairman*), Dr. C. Chree (*Secretary*), Lord Kelvin, Prof. G. H. Darwin, Prof. G. Chrystal, Prof. A. Schuster, Captain E. W. Creak, The Astronomer Royal, Mr. William Ellis, *and* Prof. A. W. Rucker, *to the British Association.* (*Drawn up by the Secretary.*)

Introductory Remarks: "*Non-cyclic*" *Effect.*

§ 1. An analysis of the results from the Kew declination and horizontal force magnetographs during the selected "quiet" days of the five years 1890 to 1894 was submitted last year to the committee and adopted as its report for 1895. The corresponding inclination and vertical force results had also been pretty fully worked up, but I held them over pending an enquiry into the sufficiency of the temperature correction. Some considerable time may elapse before these results can be utilised to full advantage. It has thus seemed inexpedient to defer dealing with one set of phenomena whose general character is unaffected by any uncertainty as to the temperature correction, and whose existence seems to render desirable a reconsideration of the whole system of "quiet" day observations. The phenomena in question bear on what I termed last year the *non-cyclic* effect.

Supposing H_0 and H_{24} to denote mean values of the horizontal force at the first and second midnights of a selected series of days, then $H_{24} - H_0$ was defined as the non-cyclic effect or variation of horizontal force; and a similar definition applies in the case of any other element.

Non-cyclic Effects During Six Years, 1890-1895.

§ 2. It is proposed to give here complete data as to the non-cyclic effects in the selected "quiet" days at Kew during the last six years. To some extent this incorporates results given last year, but it seemed desirable to show side by side the results for all the elements throughout the same series of years.

There are five selected "quiet" days a month, and so a total of 360 in the 72 months of the six years considered. In November and December, 1890, however, the vertical force magnetograph was out of action, which reduces by 10 the number of days available in the case of the vertical force and inclination.

Table II. gives the mean results for the several quarters of the year as deduced from Table I., while Table III. gives the annual means for the individual years.

Table III.—*Mean Non-cyclic Effect per "Quiet" Day for Each Year.*

Year.	Declination.	(Horizontal force) × 10^6.	(Vertical force) × 10^6.	Inclination.
1890	− 0′·36	+23	+15*a*	− 0′·10*a*
1891	+ ·29	+23	−12	− ·18
1892	+ ·14	+53	−20	− ·41
1893	+ ·26	+40	−26	− ·35
1894	+ ·15	+33	+12	− ·18
1895	− ·05	+44	−15	− ·33

a. In 1890 the means of vertical force and inclination are based on the results of only 10 months, in one of which (March) an abnormally large positive non-cyclic effect was recorded in vertical force.

Relation of Non-cyclic Effects to Annual Changes.

§ 3. To see the full significance of these data, regard must be had to the magnitudes of the annual changes of the several elements. Table IV. gives these for the period considered, along with the number of average "quiet" days, which, according to Table I., would have sufficed to produce changes numerically equal to the annual changes observed.

Table IV.

—	Declination.	Horizontal force	Vertical force.	Inclination.
Mean annual change, 1890-95	− 6′·8	21×10^{-5}	-19×10^{-5}	− 1′ 9
Number of "quiet" days producing equal change	95 *b*	6	23	7½

b. In the case of declination, and it alone, the non-cyclic effect is opposite in sign to the secular variation.

The figures relating to the horizontal force and inclination are so significant that comment in their case seems unnecessary.

As regards the declination and vertical force in individual months, notably January, the non-cyclic effects have been as large and consistent as with the other two elements, but in general this has been far from the case. As Table III. shows,

TABLE I.—Non-cyclic Effect from Six Years, 1890-1895 (Mean per "Quiet" Day).

Month.	Declination. Effect.	Declination. Individual months. +	0	−	Horizontal force (Effect) × 10^6	Horizontal force Individual months. +	0	−	Vertical force. (Effect) × 10^6	Vertical force Individual months. +	0	−	Inclination Effect.	Inclination Individual months. +	0	−
January	+0′·63	6			+50	5		1	−52			6	−0′·47	1		5
February	+ ·33	4		2	+57	5	1		+ 5	3		3	− ·35	1		5
March......	+ ·18	3		3	+28	5	1		+13	2	2	2	− ·17	1	1	4
April	+ ·12	3	1	2	+20	4	1	1	−22	2		4	− ·20	1	1	4
May	+ ·07	3		3	+38	5	1		−12	3		3	− ·27	2		4
June	− ·17	3		3	+22	4	1	1	−28	1		5	− ·22	1	1	4
July	− ·23	3		3	+27	4	2		−13	1		5	− ·22		2	4
August	− ·30	1	1	4	+37	5		1	− 8	3		3	− ·27		1	5
September......	+ ·12	3		3	+38	6			+30	3	1	2	− ·18	1		5
October	+ ·03	2	1	3	+50	6			+ 5	3		3	− ·28	1		5
November	+ ·18	3	1	2	+53	6			−12	2		3	− ·40			5
December	− ·10	1	2	3	+15	5		1	− 6	2		3	− ·12		2	3
Annual mean	+0′·072	—			+36·4	—			−8·3	—			−0′·263	—		
Totals of months......	—	35	6	31	—	60	7	5	—	25	3	42	—	9	8	53

In the case of the declination + signifies a deflection to the west. The true secular variation at present is towards the east. The components of force are measured in C.G.S. units.

TABLE II.—Mean Non-cyclic Effect per "Quiet" Day for Each Quarter of the Year.

Quarters	Declination. 1	2	3	4	(Horizontal force) × 10^6. 1	2	3	4	(Vertical force) × 10^6. 1	2	3	4	Inclination. 1	2	3	4
Effect	+0′·38	+ 01	−·14	+ ·04	+45	+27	+34	+39	−11	−21	+3	−4	−0′ 33	− ·23	− 22	− ·28

In Table I. the six Januarys, six Februarys, etc., of the six years have been combined together so as to show the values of the cyclic effects at different seasons of the year. The figures under the heading "Individual months" show in how many of the six Januarys, etc., the effect was an increase of the element in question was nil, or a decrease. At the foot of the table appear the mean non-cyclic effects per "quiet" day throughout the six years and the totals of the several columns under the headings "Individual months."

in two years out of the six both declination and vertical force have exhibited a mean non-cyclic effect opposite in sign to that supplied by the six years as a whole.

In considering such a phenomenon one ought of course to remember that it is contrary to probability that any 60 arbitrarily selected days—the number on which an annual mean is based—will produce a diurnal variation truly cyclic after allowance is made for the normal annual change; and thus part of the irregularity exhibited by Table III. may

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TABLE V.—Ranges of Elements from Annual Kew Reports.

—	Declination.			(Horizontal force) × 10^5.			(Vertical force) × 10^5.			Inclination.		
	Year.	Winter.	Summer.	Year.	Winter.	Summer.	Year.	Winter.	Summer.	Year.	Winter.	Summer.
1890	6′·9	5′·1	8′·7	21	14	30	—	—	—	′ —	′ —	′ —
1891	8·2	6·0	10·2	29	20	40	14	9	20	1·7	1·1	2·3
1892	9·6	6·9	12·3	33	26	44	17	11	25	2·0	1·5	2·7
1893	10·1	7·4	13·0	37	29	46	18	10	25	2·2	1·7	2·8
1894	9·3	7·0	11·9	36	26	48	17	11	22	2·2	1·5	2·8
1895	8·5	5·6	12·1	33	20	46	15	10	23	2·0	1·2	2·8
Means	8·8	6·3	11·4	32	23	42	16	10	23	2·0	1·4	2·7
(Non-cyclic effect) ÷ (Uncorrected range)	+·008	+·033	−·006	+·12	+·19	+·07	−0·5	−·08	−·04	−·13	−·21	−·08

TABLE A.

Greenwich.		Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.
Excess of absolute "quiet" day value above all days value	A	−0′·04	+0′·12	+0′·24	−0′·10	+0′·12	+0′·10	+0′·00	+0′·10	−0′·06	−0′·08	+0′·24	0′·00
	B	+35	+42	+24	+37	+31	+20	+22	+5	+27	+55	+51	+57
	C	+31	−26	−10	−13	−11	+10	−17	−2	+3	−40	−5	−17

A. In declination. B. In horizontal force. C. In vertical force. Mean yearly excess of "quiet" day value in declination = +0′·05; in horizontal force = +34; in vertical force = −8.

reasonably be attributed to pure chance. When, however, one looks at the uniformity of sign in the non-cyclic effects in the horizontal force and inclination exhibited in Table I., and remembers that the monthly means in that table are based on only 30 days, one must, I think, conclude that the variability of sign in the declination* and vertical force† results, at least in Table III., has probably a true physical basis.

Mean Annual Values from "Quiet" and Unrestricted Days.

§ 4. Table IV. is merely a plain statement of facts; but if too exclusively considered it might unquestionably convey an exaggerated idea of the defects attaching to the ordinary use made of "quiet" days at the present time. At Kew Observatory they are employed to get out the mean diurnal inequality for summer and winter and the whole year, as well as the mean annual values of the several elements.

As regards the mean annual value of an element, the quantity "mean value from 'quiet' days less mean value from all days" may be irregularly positive and negative, or like the non-cyclic effect in the element it may be normally of one sign. It would certainly be desirable to know which of the alternatives is true. The meaning to be attached to the secular variation deduced from two consecutive years or from a short series of years would be much more uncertain if the former alternative represented the facts than if the latter did.

In the Greenwich "Magnetical and Meteorological Observations" tables are published showing the diurnal variations both in "quiet" and unrestricted days, but not apparently direct information as to the difference between the absolute values of means deduced from the "quiet" and from unrestricted days.

At St. Petersburg, and then at Pawlowsk, it has, however, long been customary for Dr. Wild to select a series of normal "quiet" days whose results are dealt with alongside of those from unrestricted days. The principle of selection guiding the choice at Pawlowsk and Greenwich has probably been slightly different, but there is at least a strong presumption that the differences between the annual means from unrestricted days and from the the Astronomer Royal's "quiet" days will prove to be of the same character as the corresponding differences observed in the case of Wild's "quiet" days.

§ 5. The annual means for all the elements at St. Petersburg, from both "quiet" and unrestricted days, for some 12 to 16 years preceding 1885 are given in a paper by Dr. Müller in the "Reportorium für Meteorologie," Bd. XII., No. 8. In the case of every element, according to Müller's tables 20 to 23, the sign of the quantity "'quiet' day mean less unrestricted day mean," was uniformly, or practically uniformly, of one sign; and the secular variations deduced from the "quiet" and unrestricted day results, even for consecutive years, showed a remarkably good agreement. The following summary of the mean results deducible from Müller's tables is extracted from a recent paper by Leyst ("Rep. für Met.," Bd. XVII., St. Petersburg, 1894, No. 1, p. 109).

* In 1890 a *positive* non-cyclic effect appeared in only one month (January); in 1891 a *negative* effect in only one month (November).

† In both 1890 and 1894, however, a slight majority of individual months exhibited a *negative* non-cyclic effect as usual.

‡ The number in most of the earlier years dealt with by Dr Müller seems, however, to have been considerably greater.

Wild's Normal Days—all Days (Annual Means).

Declination west	+0′·25.
Inclination	−0′·23.
Vertical component	$-10^{-6} \times 8$ C.G.S. units.
Horizontal component	$+10^{-6} \times 35$,,

Tables of the monthly and yearly means for Wild's "quiet" days and for unrestricted days at Pawlowsk continue to be given in the "Ann. des Phys. Central-Observatoriums." The results from the last two volumes are as follows:

Wild's Normal Days—all Days (Annual Means).

Year.	Declination.	Horizontal force.	Vertical force.
1893	+0′·3	$+10^{-6} \times 40$	$-10^{-6} \times 30$
1894	+0′·6	$+10^{-6} \times 60$	$-10^{-6} \times 10$

There would thus appear to be no essential change in the phenomena since the period to which Müller's paper refers.

§ 6. Wild's "quiet" days numbered only 25 in 1893 and 33‡ in 1894, as against the Astronomer Royal's 60 a year; thus the results from the latter are likely to exhibit even less irregularity in their departures from the results of unrestricted days than the former. Mere surmises, such as the preceding, are vastly inferior to the actual numerical facts. Before deciding on the labour necessary to obtain the facts, one has first, however, to estimate their probable value. One factor in this consideration which the practical man can fairly urge is that accuracy in *absolute* value to anything like 1×10^{-5} in the case even of the horizontal force is an ideal we can hardly claim to have reached in this country.

Relation of Non-cyclic Effects to Diurnal Ranges.

§ 7. An idea of the amount of uncertainty which the non-cyclic effect may introduce into the mean diurnal inequalities for summer, winter, and the whole year may be derived from Table V. It gives the ranges of the elements, uncorrected for non-cyclic effect, as published annually in the Kew "Report," along with particulars as to the ratios borne by the mean non-cyclic effects to the corresponding ranges. In the case of the vertical force and inclination the year 1890 has been omitted as the results for it are not altogether complete.

§ 8. Table V. shows how much more important relatively the non-cyclic effect is in the winter than in the summer half-year.

In the winter half-year we see that the non-cyclic effect in both horizontal force and inclination is equal to about one-fifth of the range. This does not of course imply that there is an uncertainty of 20 per cent. in the range, because, whatever be the nature of the correction applied to eliminate the non-cyclic effect, it is hardly likely to introduce more than a small fraction of the observed difference between 0 and 24 hours into the algebraic difference of the maximum and minimum readings. The interval of time between these readings is in most cases nearer 6 hours than 12. The fact, however, remains that in some individual winters the uncertainty as to the range must be very appreciable. When we come to individual winter months, notably January, when the observed range is least, the uncertainty is apt to be considerable.

The preceding remarks refer exclusively to the uncertainties which the existence of the non-cyclic effect introduces into

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diurnal ranges deduced from "quiet" days. Previous reports of the committee* have dealt with differences between the ranges deduced from unrestricted and from "quiet" days. It seems to me, however, that such comparisons are open to criticism so long as the proper treatment of the non-cyclic effect remains uncertain.

Relation of Non-cyclic Effects to Diurnal Inequalities.

§ 9. In the yearly and half-yearly results the most critical point is the nature of the diurnal inequality in the late night and early morning hours. The observed variation is then small, especially in winter, so that a disturbing element of no great absolute magnitude might completely alter the character of the phenomena. This will appear at once on reference to the curves of declination and horizontal force in last year's report, pp. 212 and 220. The curves on p. 220 are certainly suggestive of the presence of some abnormal influence during the midnight hours; at the same time this is not more true of them than of curves of the same type for Greenwich which Sir G. B. Airy† based on data derived from all days but those of considerable disturbance.

Elimination of Non-cyclic Effect.

§ 10. If diurnal inequalities are to be got out at all from "quiet days" in a form suitable for harmonic analysis, they must be made cyclic, and there is certainly no simpler way of doing this than that adopted last year—viz., treating the observed data as if the non-cyclic effect proceeded uniformly throughout the 24 hours. This method of treatment does not prejudice the facts. Supposing the non-cyclic effect to proceed irregularly throughout the 24 hours, then it may most conveniently be analysed into terms, one being a linear function of the time, the others periodic functions whose periods are 24 hours or sub-multiples thereof. The linear term is eliminated by the method adopted last year. The cyclic terms of course remain, and are incorporated with the other cyclic terms of like period which go to make up the diurnal inequality on "quiet" days. It would, however, be impossible to separate the two sets of cyclic terms by any mathematical device without an addition of physical facts or a supply of theories in their place. One way of obtaining additional facts would be to compare for a series of years the constant coefficients in the harmonic analysis of the diurnal inequalities from "quiet" and unrestricted days. The accidental features introduced by the arbitrary nature of the choice of "quiet" days might, however, prove troublesome.

The term in the non-cyclic effect treated as a linear function of the time may in its turn be composed of a series of terms, some possibly fluctuating regularly with the season of the year, others possibly of very long period; its magnitude, at least in individual months, may depend in large measure on the accidental preference of one set of "quiet" days to another.

Associated Phenomena.

§ 11. It was pointed out last year (*l.c.* p. 213) that the elimination of the non-cyclic effect through a correction consisting of a linear function of the time was determined solely by considerations of convenience and mathematical simplicity. It was carefully explained (*l.c.* §§ 5, 6) that General Sabine and Dr. Lloyd had observed phenomena in magnetic storms so exactly the converse of those presented by the non-cyclic effect on "quiet" days as to suggest that the two classes of phenomena were interdependent; and the conclusion was drawn that if this interdependence were true the non-cyclic effect might be expected in reality to progress irregularly throughout the 24 hours.

These conclusions may now, perhaps, be regarded as more than surmises. In the *Met. Zeitschrift* for September, 1895, Dr. van Bemmelen has described phenomena he terms *Nachstörung*, which appear to be of the same general character as, if not identical with, what has been termed here the non-cyclic effect.

As the title he selected implies, Dr. van Bemmelen associates the phenomena very intimately with magnetic storms. His investigations have included data from a variety of stations; and whilst his theoretical conclusions may, perhaps, undergo modification in the future, his work certainly indicates that an increase of knowledge as to this outstanding phenomenon on "quiet" days is likely to be of service in the general theory of terrestrial magnetism.

§ 12. In the meantime it might be safest not to assume that the non-cyclic element is an effect, and a preceding magnetic storm a cause. The fact that the horizontal force, for instance, tends to rise abnormally fast during a "quiet" day may, of course, merely represent a recovery from an abnormal loss occasioned by a magnetic storm; but it is at least conceivable that the abnormal fall during a magnetic storm may be partly a consequence of abnormal increase preceding it, or the two phenomena may be effects of a common cause.

If "quiet" days, with no appreciable disturbance, were the rule, one might possibly determine with ease the relationships of any given "quiet" day to a preceding or succeeding disturbed day; but appreciable movements will usually be found both before and after a "quiet" day at no great interval of time. If the causes operating in large and small disturbances are the same, then it is not improbable *à priori* that a small disturbance within a day or two of a "quiet" day may have more to do with it than a large disturbance a week before or after. It should also be remembered that General Sabine found that whilst, as a rule, large disturbances lowered the horizontal and raised the vertical force, the opposite results ensued in a very considerable number of instances.

In proposing any additions to the existing "quiet" day system, or any substitute, it must be remembered that one of the main objects aimed at by its introduction was a substantial saving in the labour required to obtain comparable results from different observatories. The tabulation of the whole mass of curves was felt in most cases too serious a burden. Considerable light might be thrown on the question of the uniformity or variableness of the non-cyclic element throughout the day by a very simple addition—viz., curve measurements at the noons preceding and succeeding each "quiet" day. In the course of this paper other suggestions have been made, but they could be put into effect only at observatories prepared to tabulate all the curves.

In conclusion, I wish to acknowledge the assistance I have derived from discussing a variety of the points involved with Mr. T. W. Baker, chief assistant at the Kew Observatory.

APPENDIX.

Remarks by W. ELLIS, ESQ., F.R.S.

Having had the opportunity of reading Dr. Chree's report on non-cyclic magnetic effects, I would beg to be allowed to offer the following remarks:

I had read with great interest Dr. Chree's "Comparison and Reduction of Magnetic Observations," forming the report of the Magnetic Committee for the year 1895, in which he discusses the Kew magnetic results on "quiet" days for the years 1890 to 1894. I had lately commenced to work up in a similar way the corresponding Greenwich results in order to make comparisons between Greenwich and Kew, when treated for the same years in a similar manner. Interesting questions are involved, since it cannot be said to be at present known how far the magnetic changes at two places not remotely distant one from the other should be expected to be similar, and if not similar, to what extent there may be difference, and also whether any part of such difference might be instrumental. It is not satisfactory to compare results for one period with results for another place for a different period, because at any one place the phenomena may vary considerably at different times. But my work is not sufficiently advanced to enable me to put the results at present into shape; still I may perhaps give some information bearing on points now discussed by Dr. Chree. In Table I. he gives the mean non-cyclic effect for "quiet" days for different magnetic elements for each month of the year, deduced from the Kew observations of the six years 1890 to 1895. My numbers for Greenwich are for the five years 1890 to 1894. At Kew the non-cyclic change in declination is positive in the first five, and in the ninth, tenth, and eleventh months of the year, and negative in the remaining months. At Greenwich it is positive in the first five months and in the eleventh month, and negative in the other months. At both places the largest positive value is in January, Kew = +0′·63, Greenwich = +0′·46; the largest negative value is in August, Kew = −0′·30, Greenwich = −0′·42. Mean for year at Kew = +0′·072, at Greenwich = +0′·007. In horizontal force the non-cyclic effect at Kew is positive in all months, and similarly at Greenwich. The greatest values at Kew are (effect × 10^6 in C.G.S. units), in January, February, October, and November, +50, +57, +50, and +53 respectively; and similarly at Greenwich, the values being +62, +53, +73, and +57 respectively. Mean for year at Kew = +36, at Greenwich = +40. In vertical force there is considerable difference, both in magnitude and sign, between the non-cyclic effect in different months at the two places. The mean for year at Kew = −8, and at Greenwich = −18. In this comparison it is to be remembered that the Kew results depend on the observations of six years, and the Greenwich results only on those of five years.

As regards now the mean values in separate years (Table III.). Of the five years, 1890 to 1894, the non-cyclic change in declination is in the same direction in four of the five years at both places; in horizontal force in the same direction in all years, and in vertical force in three years. The actual numbers are:

Non-cyclic change.		1890	1891.	1892.	1893.	1894.
At Kew	in declination	−0′·36	+0′·29	+0′·14	+0′·26	+0′·15
At Greenwich	in declination	−0′·23	+0′·08	−0′·20	+0′·15	+0′·24
At Kew	in horizontal force	+23	+23	+53	+40	+33
At Greenwich	in horizontal force	+18	+37	+68	+44	+33
At Kew	in vertical force	+15	−12	−20	−26	+12
At Greenwich	in vertical force	−12	−8	−39	−24	−4

* "B. A. Report," 1886, p. 71. See also paper by Messrs. Robson and Smith, *Phil. Mag.*, August, 1890, p. 143.

† *Phil. Trans.* for 1863 and for 1885.

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In vertical force there is a tendency to a uniformly greater negative value at Greenwich than at Kew. Considering, however, the values at each station separately, the greatest negative values occur in the same two years, 1892 and 1893, at both places.

One question that I had set myself to discuss was how far the absolute magnetic values—as, for instance, the mean monthly values differ as determined from the five "quiet" days in each month and as determined from all days (excepting those of excessive magnetic disturbance). In the Greenwich "Observations" there are given in Tables I., III., and VII. of the magnetic section mean daily values of declination, horizontal force, and vertical force respectively throughout the year (excepting days of excessive disturbance). The means of these values for different months are given in Table XI. Extracting from the different tables the values for the adopted "quiet" days, and taking the mean in each month, the variation of these means from the corresponding means of Table XI. gives in each case the deviation of the "quiet" days mean from that for all days. Since the mean of the five selected days falls always near the middle of the month, the comparison, for a first enquiry, sufficiently eliminates the secular variation, considering it uniform, the only possible supposition. The excess of the "quiet" day monthly mean above the all day or unrestricted monthly mean is in each month of the year for each element, as shown in Table A (average of five years 1890 to 1894).

The corresponding separate yearly differences are :

Greenwich.		1890.	1891.	1892.	1893	1894.
Excess of absolute	A	+ 0'·01	− 0'·12	+ 0'·07	+ 0'·19	+ 0'·12
"quiet" day value	B	+ 11	+ 37	+ 31	+ 37	+ 53
above all days value...	C	− 8	− 7	− 26	− 14	+ 14

A. In declination. B. In horizontal force. C. In vertical force.

I have not sufficient opportunity at the present moment to add much by way of discussion of these numbers, but taking the element in which the difference of absolute value is most marked—that of horizontal force—some few remarks may be offered. We see that the uniformly positive non-cyclic change on "quiet" days is accompanied by an increased absolute value of horizontal force on such days, as compared with the value from all days, as we should, perhaps, expect. At Greenwich, magnetic disturbance commonly causes diminution of horizontal force, after which the value works back to a more normal one. But there are years in which the magnetic registers are unusually quiet, with few disturbances of even moderate amount, as in the years 1878 and 1879. The inference would be that in such years the difference between the absolute value for the especially "quiet" days and that for all days should be small, varying to a certain extent in different years with the more or less prevalence of magnetic disturbance. I cannot, however, for the moment refer to the Pawlowsk differences of which Dr. Chree speaks, to ascertain whether they exhibit variations of this character. Further, whether the rise of value on "quiet" days represents a recovery from abnormal loss during disturbance, or whether the abnormal fall during disturbance is in any way a consequence of preceding abnormal rise, may be a question. But the view that the recovery on "quiet" days is rather a consequence of abnormal fall during disturbance—that is, that the disturbance is really the primary dominating factor, appears to receive support from the following consideration. When disturbance suddenly arise it seems to break out over the whole earth at precisely the same moment of absolute time (see *Proceedings*, Royal Society, vol. lii., p. 191). But an instantaneous magnetic shock sensible over the whole globe could scarcely, one would imagine, arise from action from within alone ; and since magnetic disturbances are more frequent when sunspots are numerically high, there seems reason to suppose that the exciting cause is in such cases mainly external. To pursue this matter is, however, rather to enter the region of speculation.

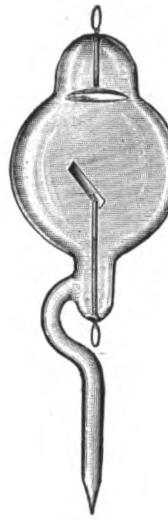
It may, perhaps, be remarked that the mean non-cyclic change for horizontal force and vertical force on "quiet" days is + 40 and − 18 respectively ; also that the mean excess of absolute value on such days over all days is correspondingly + 34 and − 8 respectively. Thus the relation in both elements is of the same character.

A part of my work consisted of a comparison of diurnal inequalities of the magnetic elements on "quiet" days with those found by including all days (always excepting the excessive magnetic disturbances), and also of a comparison of diurnal range as given : (1) by "quiet" days as observed ; (2) by "quiet" days corrected for non-cyclic change ; and (3) by including all days, in all cases for the different months of the year ; but the work is not sufficiently advanced to enable any particulars to be given.

Dr. Chree, referring to a previous report of the Magnetic Committee and to a paper by Messrs. Robson and Smith in the *Phil. Mag.* for August, 1890, speaks of the differences between diurnal ranges deduced from unrestricted days, that is all days, and from "quiet" days. I may perhaps point out that these comparisons were between "quiet" days at Kew and all days at Greenwich, and were for the element of declination only. In such a comparison the question of difference of locality must be taken into account, and also possibly to some extent the difference of instruments. But in a paper which I communicated to the *Phil. Mag.* for January, 1891, I made a more direct comparison of results, for the one year 1889, comparing the diurnal inequalities for "quiet" days (five in each month) at Greenwich with those for all days at the same place. This comparison was made for all the three elements of declination, horizontal force, and vertical force. The five-day results were not corrected for non-cyclic change, but in declination and vertical force this was evidently small. The results show a marked difference between the diurnal inequalities for "quiet" days and for all days. The later work in this direction, yet incomplete, to which I have above referred, includes a discussion of the diurnal inequalities for the five years 1890 to 1894 for "quiet" days and for all days, and the results seem likely to support those found for the single year 1889.

COMPLETE X-RAY OUTFIT.

The General Electric Company, of 69, Victoria-street, have sent us a copy of a price-list of apparatus required for obtaining X-ray effects. The rapid adoption by medical men of this means of examining the framework of the human body has caused a demand for complete sets of apparatus. So many people totally unversed in the use of electrical apparatus now have to take up the subject, that practical advice both as to the choice and working of the induction coils, batteries, and tubes is of great service. The General Electric Company have



accordingly arranged standard groups of apparatus in which the batteries, coils, and tubes are all mutually suitable. They have also equipped a small laboratory at 88, Queen Victoria-street, where the apparatus can be seen at work and practical instruction given. With each set sold instructions are given, which instructions have been prepared after the experience gained from some months' experimenting. Some two or three kinds of batteries are listed as suitable, and the choice amongst them depends on the local convenience. Where a direct-current supply for charging accumulators is available the portable sets of these secondary batteries are to be preferred, in our opinion, to any primary cells. The tubes supplied by the company are of what they call the King's College pattern, illustrated herewith. It is claimed for these tubes that they are most uniform in their action, and very durable. If these qualities are ensured by care in manufacture and selection the value of the tube is much increased, as nothing is more annoying than to have a tube failing just as an important point in the investigation is reached. The induction coils also repay the extra cost of good manufacture, and we would advise our readers that the best makes are cheapest in the long run. Some half a dozen different sets are listed, and we would suggest that in the larger outfits for hospital use spare tubes should be included.

Presentation.—Mr. George C. Sillar, works manager of the Brush Electrical Engineering Company, Limited, for the past 12 years, was married on October 14, and, to mark their respect and esteem for him, some of his friends and colleagues in the company have celebrated the occasion by presenting him with a carriage-clock. Mr. Sillar has just completed his fifteenth year of service in the Brush Company.

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THE OUTLOOK.—No. 3.

We have in previous issues harped upon a topic which really should be of absorbing interest. One point has not hitherto been touched. It is important, and is playing its part in the volume of business obtained by English firms. When we write English we include Great Britain and Ireland. Whether the business goes to England, Scotland, or Ireland is to a certain extent a matter of indifference; but when it goes to America or Belgium, or France or Germany, we ought to look carefully into the matter. Questions, then, relating to the connection between capital and labour must be considered. It is too late in the day to attempt to teach the principles of economical science to the labouring classes. We have long seen that mankind is moved more by an appeal to the passions than to logical reasoning. Men who think they can obtain an extra couple of shillings a week, or restrict the labour in that particular market to ensure high wages, have no thought nor care about indirect results. To them the only results are the direct results. To reason with such people is labour in vain. Taking advantage of this "human nature in man" is another class—a class that has existed throughout the centuries—and is the most contemptible that ever breathed the free air of heaven. This class panders for its own purpose to the passions and the ignorance of "labour." Verbosely profuse in its promises to relieve the curse of work and suffering, in reality it puts its tongue into its cheek, takes the proceeds of its verbosity, and grows fat and flourishing thereon. Emissaries from competitors in trade are ever ready to add fuel to the flames, and, if possible, to keep up a feeling of distrust between employer and employed. The result in England will prove disastrous—nay, has proved so. With the general question however, we have here nothing further to do, but will restrict our remarks to a special point. The London County Council, which should stand at the head of all municipal bodies as being a model to be followed, is probably of all such bodies the worst. It has been the sport of fads and faddists, but perhaps its worst work has been in connection with the labour question. To obtain cheap popularity, to obtain votes, many of its members have lent themselves to the propaganda of the trades unions. Its specifications contain "labour clauses"—clauses so effectual that the best firms will not tender for work. At least this is the natural conclusion from the report of the last meeting, when a committee reported that "twenty-two firms were asked to tender, of whom six declined the invitation, and five decided thereafter not to do so in consequence of the conditions of contract." Eight only of the twenty-two sent in tenders, and one of these withdrew, declining to abide by these "conditions." Practically this means that somewhere about 70 per cent. of selected firms decline to work under the County Council. If that is not a disgraceful state of things, we know not what constitutes disgrace. Here we see twenty-two high-class firms, whose sole object in life is to do business—and as much of it as they can get—asked by a corporate body having any amount of

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money at its back to tender for work, and to the extent of 70 per cent. refusing. Common-sense tells us that the question of "How much wages?" is not the point at issue. What cares a firm about "wages" if the amount comes out of the pockets of its employers? A may specify ten pounds a week to B to be paid to labourers. What does B care so long as A pays this amount and also the ordinary profits of B? The firm has, however, not only to guarantee to pay these rates themselves, but also to act as private detectives to see that the raw material they use is also worked at these rates. They have at any time to expose their trading books and wages sheets to public inspection, under the penalties which can be seen below. Now to the electrical question. The London County Council required tenders for the plant to light Blackwall Tunnel. The result of the "conditions of contract" is that the work for the engines and dynamos has been given to Messrs. Laing, Wharton, and Down, and it is divulging no secret to say this firm will probably get the equipment from America. We trust that we are in error on this point, but we are stating the generally accepted notion. If it can be proved that America is more suited to the production of such apparatus than England, we have nothing more to say. Our objection is to the driving work away from this country that can be done as well here as in another country by absurd stipulations and restrictions. To obtain the best article at the lowest price the contractor must be allowed to go to work in his own way. We give the clauses which seem to us the germ of all this evil:

"37. The contractor shall at all times during the continuance of this contract abide by, perform, observe, fulfil, and keep all and singular the stipulations following—that is to say:

"1. The contractor shall pay all workmen (except a reasonably number of legally-bound apprentices) employed by him in and about the execution of this contract or any part thereof, wages and wages for overtime respectively at rates not less than the rates stated or provided for in the third schedule hereto; and for each and every breach by the contractor of this stipulation, and notwithstanding the condonation of any prior or other breach, the contractor shall, on demand, pay to the Council as liquidated damages, and not as a penalty, the sum of £5.

"2. The contractor shall observe, and cause to be observed, by such workmen, hours of labour not greater than the hours of labour stated or provided for in the said third schedule; and for each and every breach by the contractor of this stipulation, and notwithstanding the condonation of any prior or other breach, the contractor shall, on demand, pay to the Council as liquidated damages, and not as a penalty, for each day or week as the case may be in which any such breach shall be committed the sum of 5s. per hour for every hour during which, in each day or week, as the case may be, each such workman shall be employed by the contractor beyond the maximum number of hours stated or provided for in the said third schedule, provided that this stipulation shall not be construed to prohibit overtime, if such overtime be in accordance with the rules of the trade unions concerned.

"3. The contractor shall at all times during the continuance of this contract display and keep displayed upon the site of the works and in every factory, workshop, or place occupied or used by the contractor in or about the execution of this contract, in a position in which the same may be easily read by all workmen employed by the contractor in or about the execution of this contract, a clearly printed or written copy of the third schedule hereto; and for each and every breach by the contractor of this stipulation, and notwithstanding the condonation of any prior or other breach, the contractor shall, on demand, pay to the Council as liquidated damages, and not as a penalty, and for every day during which such breach shall be or continue, the sum of £1.

"4. The contractor shall at any time and from time to time during the continuance of this work, whenever called upon so to do by the clerk for the time being of the Council, produce to such officer or officers of the Council, as the clerk may direct, the time and wages sheets and books of the contractor and all other evidence necessary or proper to show to the satisfaction of such officer or officers whether or not the stipulations contained in this clause have been and are being complied with, and allow such officer or officers to take copies or extracts from such sheets, books, and evidence, or any of them, as such, or officers may deem fit; and for each and every breach by the contractor of this stipulation, and notwithstanding the condonation of any other or prior breach, the contractor shall, on demand, pay to the Council as liquidated damages, and not as a penalty, the sum of £3.

"5. Should any workman or workmen in the employment of the contractor be not paid wages or wages for overtime in accordance with stipulation (1), the Council may pay to any workman or workmen who may have been underpaid the difference between the amount of wages which he or they may have been paid by the contractor and the amount which he would have been paid if the said stipulations had been observed, and may deduct from any moneys due or to become due to the contractor under this contract the amount of the said difference so paid to such workman or workmen."

REVIEWS.

The Elements of Electrochemistry. By MAX LE BLANC, Professor of Chemistry in the University of Leipzig. Translated by W. R. WHITNEY, Instructor of Chemistry in the Massachusetts Institute of Technology of Boston, U.S.A. London: Macmillan and Co., Limited. (Cloth, price 6s.)

Much attention has been given lately to electrochemical processes, and the establishment of what is practically an entirely new theory of electrolysis is still a matter of quite recent history. Indeed, the publication of Van t'Hoff's classic discovery of the position of osmotic pressure in the relations between solutions and gases dates back only to 1887. The whole subject has been worked out on the Continent, not entirely by "eminent Germans" (one of them was a Dutchman and another a Swede), but, at any rate, by men with whom few of those engaged in practical work in England were in touch. It may even yet be doubted whether the new theory will not eventually require addition or modification, but at present it is the standard one. Mr. Whitney's translation of Prof. Le Blanc's work is therefore a book that will be welcome, not only to the student, but to some others past the student stage, whose learning dates back to the dim and distant days of 10 or even 15 years ago. Prof. Le Blanc's book dates from the winter of 1894-95, and is the result of a course of lectures then delivered at Leipzig. It starts with an exposition of the elementary principles of electricity and the C.G.S. units, and a chapter follows mainly devoted to the early history of the galvanic cell. As, however, the reader is expected to be fully conversant with the theory of energy and heat, and have at any rate a general knowledge of the kinetic theory of gases in addition not only to understanding chemical equations (in the old and discarded, as well as the new notation), but also to be acquainted with the difference between *o*, *m*, and *p*-oxybenzoic acid, and to understand what is meant by an isochinolinmethylium ion, it is, to say the least, questionable whether this preliminary knowledge might not just as well have been assumed. But if it is understood that the book is not one to be approached without some previous knowledge, no great harm is done by the rapid revision of what to its readers will be an old tale. In Chapter III. we get to business with the Arrhenius theory of dissociation. As to the difficult question of where the heat comes from necessary for the dissociation into ions, or, put in another way, the energy necessary to separate the positive and negatively charged atoms of the molecule and convert them into free ions, we have the following: "Evidently we have a dissociation differing from that which ammonium chloride undergoes when heated. The parts resulting from the decomposition are electrically charged, and contain equivalent amounts of positive and negative electricity. It is natural to ask: Whence come these sudden charges of electricity? They seem to be produced from nothing. An answer which seems satisfactory is not difficult to give. It is known that metallic potassium and iodine combine to form potassium iodide. In this combination heat is generated, which shows that the two have entered a state in which they contain less

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energy than before. A certain amount of chemical energy doubtless still remains in the compound, and when the salt is dissolved in water, the greater part of this chemical energy is changed into electrical, through the influence of the solvent. This is the energy seated in the charges of the ions. The potassium ion is positively and the chlorine negatively electrified. By aid of the electric current it is possible to add to these ions the energy in the form of electricity necessary to give them the energy they originally possessed as elements." There are some to whom the explanation in its bare form will be difficult of reception. After the preliminary hypothesis, the book goes straight away in an exposition of the theory of the ions and their migration, and the source of the E.M.F. in a cell. This can hardly be made very easy reading, but the subject is developed as plainly as it can be. There is a valuable chapter on polarisation. In spite of their habit of upsetting established theories with new and better ones, the Germans are curiously conservative, not to say old-fashioned, in many scientific matters, and it may be worth note that the whole of the electrical explanations in the present work are given in the language of the two-fluid theory of electricity. The book throughout is an exposition of theory only. The processes adopted in practical work and the things that happen in them are not mentioned. Mr. Whitney appears to have done his work carefully and well. Some of the letters used to denote electrical quantities are not the ones we are used to in England, and the writing of the limits against the sign of integration is not exactly as we should do it here, but there is nothing of the kind which would cause even a moment's hesitation to the English reader. We have noticed what we presume are two slips in the translation, but they are exceedingly innocent ones, and beyond this there is nothing in the book which would lead a reader who did not consult the title page to suppose that it was not originally written in the English language. Probably that is about the highest praise that can be given to a translation.

A Systematic Course of Geometrical Drawing. By T. A. V. Ford, M.R.C.S.(Eng.), Assistant Master at Haileybury College. London: George Philip and Son, 32, Fleet street, E.C. (Cloth, 3s. 6d.)

Mr. Ford's book is intended to be a text-book for class use, with a sufficient number of graduated exercises necessary for the requirements of draughtsmen or engineering students, the requirements, as is natural, of the army examinations being kept in view. In England, unfortunately, our elementary theoretical geometry is hopelessly divorced from practice, and as a consequence much of our practical geometry consists of a set of directions without the student having any means of knowing the reason of what he does or why his results are correct. Consequently the whole mental value of the study is lost, and, what perhaps may be considered of more immediate importance, when a case arises which does not happen to be exactly provided for in his rote-learned text-book, the student is helpless. If he makes even the smallest deviation from the orthodox way, he does not know whether his result is right or wrong. From this reproach the present work is free. Proofs of almost all of the problems are given. But so curious is the state of opinion as to geometrical teaching that there has to be something like a half apology for this in the preface. "The proofs of the problems, when fairly easy, have been added on account of their mathematical value, and because, when understood, the recollection of the problem becomes more easy." No such apology should have been necessary, but things being as they are, the course adopted is the best possible one under the circumstances. A knowledge of Euclid is, of course, assumed throughout. The range of the book is fairly extensive. In reference to Chapters VIII. and XII. the writer cannot understand the utility of doing slowly and inaccurately, with compass and rule, work which can be done accurately by ordinary computation, or rapidly with a slide rule. But examples of this kind have to be supplied in a complete course. That the geometrical method is not the best way of getting at every result is not the fault of the book. Bearing in mind the object for which it is intended we consider the latter distinctly worthy of commendation. A complementary book on the more advanced branches of geometrical drawing is promised.

THE SUBMARINE TELEGRAPH MEMORIAL.

There has been a number of letters in the *Times* on this subject. First, "Omega," who says: "Those who, unlike Lord Selborne (the chairman at the Winchester House meeting), really know the early history of cable telegraphy know that the true pioneers were such men as Mr. Jacob Brett, Mr. C. V. Walker, Sir Charles Bright, Sir Samuel Canning, and, most celebrated of all though not earliest, Lord Kelvin. It was the demonstrated successes of these pioneers that rendered possible the subsequent financial operations of such men as Sir John Pender and Mr. Cyrus Field." "Omega" finds "an ominous note in the letter which Lord Kelvin addressed to the Marquis of Tweeddale excusing himself from attending the meeting at Winchester House on the 6th instant" (Lord Kelvin has promised to attend a meeting at the end of the month), and concludes by asking, "Is this submarine telegraph memorial going to be a memorial to the growth of submarine telegraphy, or to the greatness of Sir John Pender and of the gentlemen associated with him in the financial development of the cable companies?" Mr. G. R. Neilson, the hon. secretary of the committee, has a letter which practically says the question is an open one: "The whole subject will be fully considered by the Executive Committee at its first meeting, fixed, I may mention, for the end of the month to suit the convenience of Lord Kelvin." How can Lord Kelvin vote on the question of a memorial to himself; or the other people who are still alive? Captain H. A. Moriarty, R.N., C.B., says: "I understand that it has been found desirable to create a memorial to submarine telegraphy, and that the late Sir John Pender, Sir James Anderson, and Cyrus Field have been chosen to represent this highly scientific department. Apart from the humour of the thing, it seems to me that this selection of names is a gross injustice to the real workers in the field," and adds, "to my knowledge Sir James Anderson's only connection with submarine telegraphy, from the technical pioneer point of view, was as captain of the merchant ship 'Great Eastern' when engaged on the laying of the second and third Atlantic cables. There must be many like myself who can testify to the fact that, in the light of an engineering enterprise, Sir Charles Bright and Sir Samuel Canning were the responsible parties, as regards the various early Atlantic cable expeditions of 1857, 1858, 1865, and 1866. Like myself, Lord Kelvin was on board, and should be able to bear me out in this. Many are said to have laid the Atlantic cable, but, in reality, Bright and Canning had the work on their shoulders in the above undertakings." Mr. Henry Clifford ("assistant engineer to Sir C. Bright, first Atlantic cable; assistant engineer to Sir S. Canning, second Atlantic cable") says: "Lord Selborne's address to the committee would lead anyone to suppose that Sir James Anderson had laid the second Atlantic cable. This is an error. Sir Samuel Canning was the engineer in charge of the expedition, and upon him alone rested the responsibility of the undertaking"; and adds that Sir James Anderson was the captain of the "Great Eastern," but in no way responsible for the cable operations. With reference to the first Atlantic cable, Mr. Cyrus Field came over to England to raise the necessary capital, and Sir John Pender acted in a similar capacity in the further extension of submarine telegraphs. But "all the three names pressed forward in the proposed memorial are those of commercial men rather than of engineering pioneers in this great engineering work." Mr. Perry F. Nursey wants the work of Thomas Russell Crampton not to be overlooked, since in 1851 he "succeeded under exceptionally difficult circumstances in laying the first successful cable for a submarine telegraph between Dover and Calais." But Mr. Nursey is hardly serious in suggesting for inclusion in the memorial such a curious list of names as those of Galvani, Volta, Sömmering, Schweigger, Coxe, Romagnès, Oerstadt, Ampère, La Place, Fechner, Alexander, Sturgeon, von Cannstedt, Faraday,

Morse, Gauss, Weber, and Steinheil, "each of whom contributed a round in the ladder which was ascended by Cooke and Wheatstone." What he means to say is that the proper course "is to exclude all personal references and to let the merits of the magnificent system which the memorial is intended to commemorate be the foundation upon which it is reared." Mr. John Temple writes substantially to confirm the letters of Captain Moriarty and Mr. Clifford. As seen above, Mr. Perry F. Nursey suggested that the late Mr. T. R. Crampton "may be regarded as the father of practical submarine telegraphy." In reference to this, Mr. Charles Bright writes: "No single individual can be justly spoken of in that light, as it is a work which has been gradually built up in different directions by many hands. It would, perhaps, be more to the point to refer to Sàlva (1795) as the father of the idea of submarine telegraphy, and to Pasley (1838) as the first to devise and lay an insulated telegraph line under water with good effect. Between these periods Sömmering and Schilling (1812) are said to have exploded mines by subaqueous electric conductors by their own design and arrangements." Mr. Bright adds, "With the last sentence of Mr. Nursey's letter [suggesting the exclusion of all names] all will, no doubt, agree." We have summarised other opinions above—our own will keep.

A COMPLETE TEST OF MODERN AMERICAN TRANSFORMERS OF MODERATE CAPACITY.

BY A. H. FORD, B.Sc.

We have received the bulletin of the University of Wisconsin containing the valuable results of the above test. We abstract the same somewhat fully, so that our readers may compare the results with those obtained by English makers of transformers. The full matter formed the thesis submitted by the author to the university for his bachelor of science degree.

Transformers were obtained from all the leading makers of America, and tested to determine the following data: the copper loss; the iron loss both when the transformer is hot and when it is cold; the division of the iron loss into hysteresis loss and Foucault current loss; the open circuit current; the regulation and magnetic leakage effect; the rise of temperature at full load and no load both if the transformer is in its case and when directly exposed to the air; and, finally, the insulation of the coils. Before proceeding to test the transformers, the author compared the different methods of making the required tests, to ascertain which method was the most accurate. He found that Dr. Sumpner's method was preferable. By this a wattmeter is used first to determine the iron loss at no load. Then the secondary circuit of the transformer is short-circuited through an ammeter, and sufficient voltage applied to the primary circuit to maintain the full-load current. The wattmeter then gives the copper loss together with a small iron loss which is practically negligible. The transformers were tested both at 60 and 125 complete periods per second. The first transformer on the list was an arc lighter transforming to constant current. All the rest were for constant-potential work. Table I. gives the details of the losses and efficiencies of these various transformers, arranged conveniently for reference. Table II. shows the iron losses per pound of iron used, and the maximum induction to which the iron of the respective transformers was subjected. It also gives the total drop of pressure in the secondary between no load and full load, and the proportion of this drop due to magnetic leakage. The author then proceeds to discuss the results of the tests, but with some of his conclusions we cannot agree. Thus, speaking of the iron loss, he says (page 79): "From the results in Table II. it is seen that the magnetic density has a very large effect on the iron loss, the loss per cubic centimetre increasing much faster than the value of B, which would lead one to increase the area of the cross-section of the iron in a transformer core, thus decreasing the value of B. That this is correct is shown by the following computation:

$$H = K B^{1{\cdot}6} = \frac{K N^{1{\cdot}6}}{A^{1{\cdot}6}} = \frac{K N^{1{\cdot}6}}{(V^{2}/_{3})^{1{\cdot}6}} = \frac{K N^{1{\cdot}6}}{V^{1{\cdot}07}}.$$

H is the total hysteresis loss, B is the magnetic density, N is the total number of lines of force, A is the area of a cross-section of the core at right angles to the direction of

TABLE II.

No.	Iron loss, watts, per lb.		B.		Total drop.		Leakage drop.	
	n = 125.	n = 60.	n = 125.	n = 60	n = 125.	n = 60	n = 125.	n = 60.
1	·96	1·61	3 770	7,870	82·0	21 0	78·0	15 7
2	·62	·86	—	—	3·1	3 2	·1	·3
3	·46	·64	2 050	4 280	2·3	3 5	·5	1 3
4	·75	1 00	2,600	5,400	3·5	2 8	1·9	1·1
5	·85	1·25	3,640	7,500	2·9	2·0	1·0	·1
6	2·14	3·93	3,750	7 720	1·8	1·2	1 1	·4
7	·85	1·25	3 630	7 560	4·9	3·3	2 6	9
8	·32	·42	1,960	4,080	2·6	2·7	—	—
9	1·42	1·82	—	—	4 0	3·1	2·4	1·5
10	·48	·67	2,380	4 960	2·7	1 8	·7	—
11	1·07	1·39	4,670	8,460	2·8	2 2	1 0	·4
12	·82	1·06	3,210	6 650	3·8	2·0	1·2	—
13	·84	1·21	—	—	4 6	3 4	2 4	1 2
14	·75	1 50	5,250	10,950	5 2	4·7	2·1	1·5
15	·93	1 21	3 540	7,470	5 3	4·2	2·8	1·7
16	1·43	2·74	3 120	6,400	2·1	2·5	·7	1·1

n signifies the frequency or number of complete periods per second.

TABLE I.

No.	Output, watts.	Iron loss.		Copper loss, maximum	Efficiency maximum.		All-day efficiency.		Open-circuit current.		Power factor at no load.	
		n=125.	n=60		n=125.	n=60	n=125.	n=60.	n=125.	n=60.	n=125.	n=60.
1	450	23·4	38·6	12·2	92·5	90·0	78·4	69·6	·033	·061	·710	·634
2	1,000	24·4	27 6	32·8	94·9	94·4	87·2	85 8	·028	064	·752	·520
3	1,250	37 0	48 5	29·7	95·0	94·0	85 1	83·0	·043	·066	·840	·730
4	1,500	50·5	70 6	45·2	94·6	94 0	84·8	80·6	·076	·124	·640	·565
5	1,500	45·7	60·1	36·2	94·8	94·0	85 5	83·4	054	·099	817	·615
6	1 500	126·0	206·0	14·8	91·5	97·4	70·8	60·0	·173	·475	·650	·400
7	1,500	32·2	46·5	38·1	95·7	94·5	89·4	85·0	·052	·100	·620	·465
8	1,500	33·7	44·6	57 5	94·7	94·2	86·0	85·3	·054	·068	·628	·656
9	1,500	97·5	125 0	38·5	91·7	90·1	76·5	70·2	·124	·190	·786	·657
10	1,500	31·5	44 5	44 0	95·6	94·7	89·0	85·8	·050	·076	·615	·590
11	1,500	57·5	76·0	30·9	94·5	93·4	83 0	79·2	·073	·113	·796	·672
12	1,500	43·2	55 5	28·5	95·3	94·6	86·5	83·7	·077	·144	·556	·384
13	1,500	57 0	82 0	35·3	93·7	92·0	83·0	77·8	085	·125	·670	·656
14	1,800	53·5	108 7	66·6	94·0	91·7	84·7	75·5	·076	·600	·710	·182
15	2,000	42·4	56·3	54·8	95·2	94·5	88·6	86·5	·055	·091	·785	·630
16	2,500	135·0	230·0	44 4	92·5	99·0	77·0	68·0	·230	·540	·585	·430
17	7,500	74 0	100 0	240·0	96·7	96·4	93·1	91·2	·116	·168	·638	·595
18	7 500	90 0	122·0	160·0	97·0	96·6	92·8	91·0	·160	·209	·566	·585
19	1,000	19·0	29 0	28·0	95 6	94·5	89·5	85·8	·028	·047	·680	·620
20	4,500	49·5	70·0	100·0	97·1	96·5	93·0	91·1	·080	·100	·62	·70
21	10,000	103·0	144·0	160·0	97·5	97·2	93 8	92·0	·160	·230	·61	·64

n signifies the frequency or number of complete periods per second.

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the lines of force, V is the volume of the core, and K is a constant. This equation holds for transformers made of the same quality of iron, and having the same shape of core. Consequently, if the winding, and therefore the total core magnetism, of a transformer is fixed, the core losses may be decreased by increasing the volume of the iron in such a way that the magnetic density is proportionately decreased."

The fault in this reasoning is the common fault in all analytical attempts to establish fixed rules for transformer design. The circuits of a transformer are so interdependent that the winding cannot be considered as an invariable, while the dimensions of the iron circuit are varied. The conclusion above would only be accurate if an increase in the dimensions of the iron circuit did not necessitate the use of more copper. In fact, the efficiency of a transformer is not beyond a certain point improved by an increase in the dimensions.

From a comparison of the iron loss in the transformers tested, we see that a test of the iron for its hysteresis loss before it is put into a transformer is a very essential matter if a good transformer is to be made. "The all-day efficiencies given are calculated as though the transformers ran 19 hours on no load and five hours on full load. The total watt-hours' output thus calculated may be taken to approximately represent the number of watt-hours which a transformer is likely to be called upon under rather favourable conditions to deliver in a day where each house or group of houses has a separate transformer. The all-day efficiency equals the total energy (watt-hours) given out by the transformer in 24 hours divided by the energy (watt-hours) given to the transformer in the same time. From a comparison of the all-day efficiencies with the maximum efficiencies we see that the transformer with the least total loss at full load, while it has the greatest maximum efficiency, may not have the greatest all-day efficiency. This consideration shows that it may be of advantage to put many turns of wire in the coils of a transformer, thus increasing the copper loss and reducing the iron loss by making the core smaller and reducing the magnetic density. The number of turns should not be so large as to make the C R drop excessive, or to increase too much the cost of manufacture." The author should also add that the magnetic leakage debars the undue application of this idea.

The leakage drop was determined by deducting the C R drop from the total drop in voltage measured. As the leakage effect is generally small, and is thus found by differences, it is likely to be affected by error of observation. Still, due precautions against error were taken. The drop is seen to be generally less for a frequency of 60 than that for one of 125, which is as it should be. The few cases where the inverse is seen must be put down to errors of observation.

The tests of the temperature rise with the different transformers gave, as might be expected, somewhat discordant results. Still, the following, in the author's opinion, may be taken as a fair average conclusion: For a rise of temperature of 40deg. C. the watts radiated per square inch of core and coils is—with the case on ·21, with the case off ·27, and per square inch of case with the case on ·15 of a watt.

The following are the conclusions drawn by Prof. Dugald C. Jackson on the results of above test:

The complete tables of the results show strikingly that the cheapest transformer is not always the most economical, and that individual tests of each transformer purchased are essential to assure economy. Transformers should be purchased under guarantees of iron loss, regulation, heating, disruptive strength of insulation, and open circuit or exciting current, and every careful electric light superintendent can do no less than test every transformer delivered to him for at least the first two items (iron loss and regulation). These tests are easily made, provided an ordinary wattmeter is at hand.

The guarantees which should be required for transformers are as follow:

1. Iron loss of transformer when operated on circuit at normal pressure never to exceed the values given in the table below for frequencies over 100 periods per second (it may be advisable in some cases to accept a 10 per cent. higher loss for a frequency of 60, in order that the first cost of the transformer for this frequency need not be increased).

2. Drop of secondary pressure due to loading the transformer not to exceed 3 per cent. between no load and full load.

3. Excess of temperature above that of surrounding air at full load after working 10 hours not to exceed 70deg. F. (nearly 40deg. C.).

4. Disruptive strength of insulation between coils and between primary coil and iron, when heated by 10 hours run, to be at least 10 times the primary pressure. Insulation resistance, when heated as above, to be not less than 10 megohms, and guaranteed not to deteriorate with reasonable service.

5. Exciting currents for 1,000-volt transformers not to exceed values given in table when the frequency is above 100. If the frequency is less, the exciting current may be expected to increase as the frequency decreases. In transformers intended for other pressures than 1,000 volts the exciting current may be expected to vary inversely as the pressure. Consequently, if the exciting current of a 1,000-volt transformer is tested by connecting its low-pressure coil to the 100-volt lighting circuits the amperemeter reading may be expected to be 10 times as great as the value given in the following table:

Capacity.	Iron loss.	Exciting current.
1,000 watts	30 watts	·055 ampere.
1,500 watts	40 watts	—
2,000 watts	50 watts	·080 ampere.
2,500 watts	60 watts	—
4,000 watts	80 watts	—
6,500 watts	100 watts	·100 ampere.

For intermediate capacities, intermediate values of the iron loss and exciting current may be expected.

We believe that English makers are prepared to guarantee better results than the above in every detail, except, perhaps, the breakdown pressure. Ten times the primary pressure is a most severe test, and one which we think to be unnecessary. The transformer will never be subject to anything approaching that pressure when at work. It will be noticed from this table of iron loss and exciting current that the professor has a most erratic power factor in his standards, but this is most likely attributable to the printers.

APPLIED ELECTRO-CHEMISTRY.*

BY JAMES SWINBURNE.

LECTURE III.

(Concluded from page 441.)

The anode does not give any serious trouble. Carbon is practically indestructible in fused chloride of sodium, as even hot chlorine has no action on it. If the salt contains any oxygen compounds, such as oxide of sodium, due to combustion of the sodium or sulphate of sodium, a carbon anode will of course be attacked and eaten away. The chlorine that comes off must be kept within some sort of hood, and this gives rise to a new difficulty. Red-hot chlorine, if one may use such an expression, is not at all convenient to handle on a large scale. Perfectly dry chlorine is said not to attack metals, and sodium will keep a bright surface in contact with dry chlorine, but though the chlorine from red-hot salt must be fairly dry it attacks metals at once. No metal can be used as anode in fused salt, for instance, and after it has come off the chlorine will attack, say, an iron hood. Then there is also difficulty in making good contact between the conducting lead and the anode, as the lead, being metal, cannot be in contact with the hot chlorine, and the carbon, on the other hand, must not be exposed to the air. On a large scale it is probable there will also be some difficulty in cooling large quantities of chlorine, as the chlorine must, of course, not be led into the bleach chambers already hot.

The cathode itself of course offers no difficulty. Iron or, perhaps, copper can be used. Sodium, however, floats on fused salt. The surface round the cathode must therefore be covered in, and the sodium either collected and poured off or distilled over. To distil sodium needs a fairly high temperature, which, other things being equal, is a drawback. A still greater

* Cantor lectures delivered before the Society of Arts.

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drawback is that the sodium does not distil clean, but comes over mixed with salt vapour, and the sodium and salt are condensed together, making a mixture which is difficult to treat.

The chief difficulty as regards the cathode is the hood. Such materials as porcelain are attacked by sodium or sodium vapour, so sodium must not come in contact with them. If iron or copper is employed, as soon as there is a layer of sodium on the top of the salt it makes contact between the cathode and the hood, and the further liberation of sodium is on the outside of the hood, where the metal burns. This not only means waste, but the oxide formed dissolves in the fused salt, and finally burns the carbon anodes. Porcelain hoods have been tried. Many kinds of stoneware or fireclay will stand fused salt well enough; but it does not follow that it will stand in an electrolytic vat. Apparently at the temperature of fused salt it conducts enough to be practically electrolysed. Poincaré gives the conductivity of hot porcelain as about a hundred-thousandth of that of fused salt. It may also be partly attacked by the rather mysterious subchloride of sodium which is supposed to be produced. Such a compound may reduce silicates, just as sodium does. Borchers has proposed or used chamotte, which is, I believe, stoneware made of old fired stoneware, ground up and mixed with new slip and again fired. I do not know what success this material secured. Another proposal is to use porcelain hoods both for the anode and cathode, and to prevent any action by keeping them cool by water circulation. The hood is then coated at all vital points with a casing of cold solid salt, which is an insulator, and protects the porcelain from all attacks on the part of the salt, electrolysis, sodium, or sodium subchloride. Still, the close proximity of melted salt, red-hot sodium, chlorine, and cold water, with nothing but porcelain to separate them, must always be discouraging to a workman whose life is not insured. When all the difficulties so far mentioned have been successfully surmounted, there is still another drawback, and that is that probably there will be no sodium. If a small current density is used no sodium will appear. It was most likely this phenomenon that led the earlier experimenters to suppose that fused electrolytes conducted without decomposition, like metals. What really happens it is very difficult to say. It is generally supposed that the sodium forms a subchloride, but a subchloride of a monad element is a little difficult to believe in. Photographers are on very familiar terms with subhaloids of silver, so we must not be too sceptical about subchlorides of sodium. If the cathode is watched in a cell of fused salt, the liquid appears to be violently disturbed, and luminous red streaks come from the cathode. This looks rather as if sodium was being carried in clouds of small particles into the mass of the salt, and these combined with the salt with evolution of heat. If salt is taken from the neighbourhood of the cathode and cooled, and examined through the microscope, it is found to be full of black specks. On adding water there is effervescence. This looks as if the sodium was not in the form of subchloride, but in little metallic globules. The luminous clouds may be merely clouds of globules of hot sodium, the high temperature being due solely to the enormous current density in the immediate neighbourhood of the cathode. The presence of sodium, or of particles that may be assumed to be sodium, in the cooled salt does not show that they exist at the higher temperature. It is possible that subchloride of sodium exists at the temperature of melted salt, but splits up into normal chloride and sodium on cooling. Lithium if heated in contact with lithium chloride in a closed vessel disappears, apparently forming a subchloride. The subchloride of lithium has even been investigated as regards its fluorescent properties. Chloride of sodium acted upon by cathode rays in a vacuum tube gives off chlorine and turns orange or bluish, and subchloride is said to be formed. Lithium chloride is said to be decomposed in the same way.

It is possible that sodium is not actually deposited against or on the electrode, but in the immediate neighbourhood only. If mercury is used as cathode in a strong solution of a lead salt and a current density is employed, it will be found that lead trees grow on the surface of the mercury. Mercury amalgamates clean lead at an enormous rate—so fast that if you agitate the cathode by touching the cell, trees several inches long will disappear into the mercury so quickly that the eye cannot follow the movement. If the surface of the mercury is watched, it will be seen that the lead is always beginning to form trees, but they are rapidly sucked in by the mercury. It appears as if the lead is not deposited into or really in contact with the mercury, but is thrown down in its immediate neighbourhood, and is then amalgamated by the mercury. If this is the case, it may account for the small yield of sodium from fused salt. It is possible the sodium is deposited in very small globules in the immediate neighbourhood of the cathode, and that a large proportion of it is swept away by the surging salt, and is eventually burnt on the surface of the electrolyte, or turned into salt again at the anode.

The melting point of salt is reduced in practice by adding other chlorides, such as that of calcium, to the bath. Of course, only those chlorides can be used which do not deposit metals more readily than salt. It is quite possible that a little calcium is deposited with the sodium, but it is so difficult to make sodium commercially by this method that an inventor would feel quite encouraged if he obtained any sodium to speak of, even if it were largely contaminated with calcium.

The difficulty, as regards the collection of sodium, has been overcome by Vautin in a very ingenious way. He uses a cathode of fused lead. According to Borchers, whose works are a veritable mine of information, this idea is old, as Rogers deposited sodium into lead and zinc in 1886-89, and published an account of his successful results. Vautin has gone further than this, however. The lead-sodium alloy is in connection with a second vat to which steam is admitted. This takes out the sodium, and if the steam supply is properly regulated pure fused caustic is produced, and has only to be run into drums and sold. This arrangement overcomes a great many of the difficulties inherent in the electrolysis of fused salt. There is no difficulty in collecting the chlorine, as the sodium does not also rise to the top of the vat.

Lead-sodium alloy is available for very many of the purposes for which plain sodium is employed. It would probably not pay to use it for getting aluminium, as the electrolysis and substitution would probably cost more than the simple electrolysis of a cryolite and alumina bath. It is available for the production of cyanides from potassium ferro-cyanides. As sodium has a lower combining weight as well as a lower price than potassium, sodium cyanide is on the whole preferable to potassium cyanide; and it is, I believe, just as good in gold extraction. It must be practically entirely ionised in the very weak solutions used in leaching gold ores, so the metal can hardly make any difference. As potassium cyanide is estimated by its cyanide, the metal being assumed, the use of sodium in the reaction with the prussiate of potash gives a cyanide which tests at over 100 per cent. This has astonished not a few analysts, but is pretty generally understood now.

LECTURE IV.

Electrolytic Caustic and Bleach.

Inventors are still devoting their attention to curious vats and queer diaphragms. In some ways it seems as if too much attention has been given to electrolytic alkali. The alkali business is so enormous that it is a great temptation to inventors, but, on the other hand, the products are low priced, and therefore there is not so much margin. It does not seem to be quite well enough understood that electrolytic alkali is not waiting for some wonderful vat. The processes already in use are quite good enough to give enormous profits if worked economically, but careful supervision is necessary, and great attention to detail. Unfortunately such processes generally get into the hands of limited companies, and limited company management is seldom conducive to success in such cases. It must also be borne in mind that the cost of the electrolysis itself is a small portion of the cost of making electrolytic caustic and bleaching powder. So small a portion of the cost is it that a great improvement in the vats would make very little difference in the price of the finished material. Unfortunately everyone wants to have a vat or system of his own invention. A manufacturer who started up with the determination to use no apparatus which was patented or called after anybody would have a much better chance of success, especially if he employed a few sharp young chemists to watch the vats, make tests, and find out the very best conditions for working. Generally the various inventions consist of varieties of porous diaphragm. Of course an arrangement like that of using mercury as an anode and cathode in one is a different matter. This gives pure caustic, as there is no chlorine in the cathode chamber. If no hydrogen is given off at the surface of the mercury in the anode compartment, the current efficiency must be unity. Having no salt in the caustic means considerable economy in finishing.

Some injustice has been done to this process by those who have raised the cry that the mercury is poisonous. There can be no danger whatever in such a case. I have had charge of lampworks where mercury is used in the exhausting rooms, where it seems to be ubiquitous. Yet all that is needed is to keep the mercury clean, so that it does not flour or powder. When a glass pump breaks, the mercury gets all over the linoleum-covered floor, and is merely swept up. In spite, of this, I have, in several years, never had the slightest case of salivation. When the mercury is permanently under liquid, as in the alkali process, it is quite absurd to suggest danger to the health of the workmen.

One of the difficulties in making bleach is that the anodes are attacked, and a proportion of carbon dioxide is given off with the chlorine. This converts some of the lime into chalk, and lowers the possible percentage of available chlorine. I have found—at least on a small scale—that this difficulty can be overcome by letting the chlorine and carbon dioxide first pass over some bleaching powder, which takes up the dioxide, giving off chlorine instead. When it is converted into chalk it is thrown away. It would be useless to burn it into lime, as it

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contains chloride as well as carbonate. By this means good bleach can be made. It seemed possible that the carbon dioxide would evolve hypochlorous anhydride, which would be taken up by the lime, giving bleaching powder with a higher percentage of available chlorine than usual. It is doubtful if such a reaction takes place, and still more doubtful if it could be worked on a large scale. Mr. Charles Waite was, however, before me in working out this scheme, and it has been in operation at the Rumford Falls Electrochemical Works for some time now.

Recently, Dr. Hurter has urged that it is impossible to get strong caustic in an ordinary vat at a high current efficiency. I do not understand Dr. Hurter's reasoning, and so I may quite unintentionally misrepresent his views. At a discussion on Mr. Hargreaves's paper, at the Society of Chemical Industry, where I first heard Dr. Hurter's views, I suggested that he was confusing the carriage of the charges by the ions with the liberation of the final products at the electrodes. I have not seen the printed account of this meeting yet, so do not follow Dr. Hurter, but he kindly sent me a paper read by him at the Liverpool Physical Society in 1893. Unfortunately I cannot follow this either, but as far as I can make out Dr. Hurter thinks that in a solution containing salt and caustic the current is carried partly by the hydroxyl ions and partly by the sodium and chlorine ions, with which I agree; and that the portion carried by the hydroxyl, or by the hydroxyl and some of the sodium ions, is useless because it does not make more caustic, with which I disagree entirely. As long as there is available chloride in the immediate neighbourhood of the anode, chlorine and not oxygen will be evolved. At the cathode again hydrogen must be evolved. This being the case either caustic and chlorine are made, or caustic gets at the anode and takes up the chlorine, making hypochlorite and perhaps chlorate.

(*To be continued.*)

LEGAL INTELLIGENCE.

CLAIM FOR ELECTRICAL GOODS.

At the Westminster County Court on Tuesday, before his Honour Judge Lumley Smith, Q.C., the case of Holt *v.* Leonard was heard.

In this case the plaintiff, Mr. George Holt, who described himself as an electrical appliance dealer, of Wardour-street, W., sought to recover a balance of account in respect of six arc lamps supplied to the order of the defendant. The plaintiff's case was that six lamps were supplied, and that four had been paid for, but it was not until months after the goods had been supplied and payment had been repeatedly applied for, that the defendant put forward some excuse about a defect. If the lamps had been in any way wrong witness would have changed them, but he was never asked to do so.

The defendant was called, and admitted that it was not until several months after the delivery of the lamps that he made any complaint; and upon this evidence his Honour gave judgment for the plaintiff, with costs.

COMPANIES' MEETINGS AND REPORTS.

BRUSH ELECTRICAL ENGINEERING COMPANY, LIMITED.

The confirmatory meeting for the reduction of the share capital of the Company is to be held at Cannon-street Hotel, E.C., on November 2 at noon. The proceedings at the first meeting have been reported in our columns. A circular has been issued by the secretary of the Company (Mr. Broadhurst), as follows: "For the reasons pointed out in the report recently issued to the shareholders, it has been decided to reduce the Company's capital by writing off £1 from the nominal value of each of the 90,000 ordinary shares. For the benefit of those shareholders who were not present at the meetings of the Company on 5th inst., the directors have desired me to explain the effect of the proposed reduction in greater detail than appeared in the report. Under the constitution of the Company the holders of preference shares have a preference in dividend, but not as regards capital; and therefore, in the event of the Company going into liquidation (a remote contingency), the holders of ordinary shares would be entitled to receive three-fifths and the holders of preference shares two-fifths of any surplus assets, after payment of debentures and other debts and liabilities and the expenses of liquidation. After the capital has been reduced in the manner proposed, the holders of preference and ordinary shares will be entitled to participate in equal shares in the assets on winding up, and neither class of shareholders will be in any way prejudiced as regards dividend. The directors, who hold a large number of ordinary shares themselves, have, after careful consideration, decided that under all the circumstances the proposed mode of reduction is the best available, and wish to point out that, as it will facilitate payment of dividends, the holders of ordinary shares will reap the main benefit of the proposed reduction so long as the Company is a going concern. A reduction of the preference capital would entail an immediate and continuing loss on the holders of preference shares, and would have the effect of transferring part of the dividend to which they are now entitled to the pockets of the holders of ordinary shares. The resolution for reduction was discussed at some length at the meeting of the Company held for the purpose on 5th inst, and was eventually passed by a majority of 42 to 10. In order to obtain the sanction of the Court to the reduction it is desirable to have as many votes as possible recorded at the meeting to be held on November 2." With the circular is enclosed a report of the former meeting, and proxies are asked for.

ELMORE'S FRENCH PATENT COPPER DEPOSITING COMPANY.

A meeting of this Company, which is in liquidation, was held last week at Winchester House, E.C., Mr. J. H. Duncan, the receiver and liquidator, presiding.

The **Chairman** said the meeting had been called for the purpose of putting one particular point before those interested in the Company before he closed up the accounts and terminated his office Under a scheme certain bonds were issued to them on the English company, which was the holder of all the founders' shares of the French company. So far, the founders' shares were not in receipt of any dividends. The bonds were now in default, and it would have been possible if the liquidator had not been in the way for any creditor to commence proceedings. He had, therefore, delayed the closing of the accounts and the liquidation to prevent these proceedings being taken. Now, however, the inspector of the Board of Trade wanted to know why he did not close the accounts, and he had, therefore, called them together to ask their assent to continue in office. With regard to the progress of the French company by the French capitalists, he might say that the business in France had been taken in hand in a way that could not have been done on this side. Although numerous difficulties had been encountered, they had paid two dividends, amounting to 5 per cent. on the share capital, in addition to paying 6 per cent. interest on the bonds. The founders' shares did not benefit until 10 per cent. had been paid, and reviewing the general prospects he expressed his opinion that there was reasonable expectation that the founders' shares would in time become valuable. The French company was turning out 150 tons a month.

On the motion of **Mr. Shurmer**, seconded by **Mr. Harman**, a resolution was passed requesting Mr. Duncan to continue in office, subject to the approval of the Board of Trade.

MONTE VIDEO TELEPHONE COMPANY.

The annual general meeting of this Company was held yesterday (Thursday) at Winchester House. The directors recommended a dividend of 4 per cent. on the preference share capital of the Company. The **Chairman** (Mr. H. Ward) stated that during the year a marked improvement had been made in the Company's service by the introduction of a new microphone. Mr. F. W. Jones was re elected director, and Messrs. Gérard Van de Linde and Son were re-elected auditors. The balance-sheet, which was taken as read, shows a balance on the profit and loss account of £838. 4s. 7d. to be carried forward to next year.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY, LIMITED.

The report of the directors of this Company for the half-year ended June 30 last states that the revenue for the half year amounted to £92,071 and the working expenses to £19,210. After providing £3,200 for debenture interest and sinking fund and £1,649 for income tax, there remains a balance of £68,011, to which is added £15,049 brought forward from December 31 last, making a total of £83,060. A quarterly interim dividend, amounting to £19,500, has been paid and £20,000 transferred to the reserve fund. The directors now recommend the declaration of a final dividend of 3s. per share, making with the interim dividends a total dividend of 6 per cent. for the year, and also the payment of a bonus of 2s. per share, both free of income tax, which together will amount to £32,500, leaving a balance of £11,060 to be carried forward. The dividend and bonus will be payable on 29th inst. The receipts for the half-year include the sum of £1 500 dividend to December 31 last on the Company's shares in the African Direct Telegraph Company. The various sections of the Company's lines are in good working order.

The shareholders' meeting is next Wednesday at Winchester House.

EASTERN EXTENSION TELEGRAPH COMPANY.

The report of the directors of the Eastern Extension, Australasia, and China Telegraph Company, Limited, for the half-year ending June 30 states that the gross receipts, including Government subsidies, have amounted during that period to £313,915, against £264,138 for the corresponding half-year of 1895. The working expenses, including £19,917 for cost of repairs to cables and expenses of ships, absorb £87,256, against £95,255 for the corresponding period of 1895, leaving a balance of £226,659. From this is deducted £4,028 for income tax, £20,000 transferred to the

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fire insurance fund, £31,895 for interest on debentures, debenture stock, and contribution to sinking fund, leaving £170,735 as the net profit for the half-year. Two quarterly interim dividends of 1¼ per cent. each, amounting to £62,500, have been paid for the half-year, leaving £108,235, of which £75,000 has been transferred to the general reserve fund and the balance of £33,235 is carried forward. The working of the Australasian tariff arrangement for the fifth year of guarantee ended April 30 last, resulted in the guaranteed figure being again exceeded. This was due to the heavy gold-mining traffic with Western Australia during the past year. In addition to the revision of the local rates referred to in the last report, and which took effect on July 1 last, the directors have decided to make substantial reductions of tariff between India and China, Japan, etc., to come into force on January 1, 1897. Reductions in most of the Company's through rates were also agreed upon at the International Telegraph Conference recently held at Budapest, several of which will come into force on January 1 next, and the remainder on July 1, 1897. The immediate effect will undoubtedly be a falling off of revenue, but it is hoped that in time the loss will be diminished by increase of business. The long pending negotiations between the Company, its partners in the China traffic—the Great Northern Telegraph Company—and the Chinese Telegraph Administration, for a friendly working arrangement, have at last been brought to a satisfactory conclusion. The arrangement not only restores amicable relations between the Administration and the companies, but settles the troublesome question of exchange, from which the Company has so severely suffered in the past, by enabling it to collect in Chinese currency a fair equivalent for its sterling charges. The agreement was ratified by all the interested Governments on July 31 last, and brought into operation on the following day.

The Marquis of Tweeddale has been appointed chairman, and Mr. F. E. Hesse to the position of manager as well as secretary.

The Company's meeting is at Winchester House on Wednesday next.

HOVE ELECTRIC LIGHTING COMPANY, LIMITED.

The Secretary, in forwarding the notice and warrant for interim dividend, has issued a circular to state that the business of the Company continues to improve satisfactorily. The number of consumers has increased to 305, and the lamps attached to the Company's mains are now equivalent to 20,911 lamps of 8-c.p., while the net revenue for the half-year ending June 30 has increased by nearly 25 per cent. over the amount for the corresponding period of last year. The directors have pleasure in stating that the 5 per cent. debentures were duly paid off on July 1, according to notice, and the loan from the Company's bankers has also been extinguished. The total debentures now issued are £7,300 at 4½ per cent., and £14,600 at 4 per cent. The whole of the share capital of the Company has been subscribed, the last 922 shares at a premium of 10s. per share. The reserve fund now amounts to £1,287. Considerable extensions are being made to the Company's mains to meet the demands of new consumers.

CONTRACTS FOR ELECTRICAL SUPPLIES

CONTRACTS OPEN.

Bucharest.—Tenders will be received at the Mairie, Bucharest, on November 16 for two stand-by steam-engines for a water-power electric generating station at Grozavesti.

Wolverhampton.—Tenders are required for an electric lighting heating and cooking plant for the Victoria Hotel, Wolverhampton. Specification may be seen on application to Mr. Thomas J. Barnett, secretary, 25, Darlington-street, Wolverhampton.

Homburg v. d. Hohe.—The City Authorities of Homburg v. d. Höhe will receive offers up to November 1 for undertaking a concession for the erecting and working an electricity supply station for the city. For particulars application should be made to die Städtische Bauverwaltung, Homburg v. d. Höhe.

Dublin.—The Dublin Bread Company, Limited, invite tenders for a motor van. Particulars, specifications, conditions, and form of tender may be obtained at the office of the consulting engineer, Mr. F. J. Warden-Stevens, A.M.I.E.E., 34, Victoria-street, Westminster, on deposit of £2. 2s., which will be returned on receipt of a bona fide tender.

Werl (Germany).—The Local Authorities propose to submit to tender the construction and maintenance of an electric power and lighting generating station, and also an electric tramway from Werl to Wikede, with an eventual extension to Hamm. Further particulars will be obtainable at the Rathhaus, Werl-i.-Westf., Germany. The date for the tenders is November 3.

Cologne.—Tenders are required by the Municipal Authorities for the construction and working of electric tramways in the city of Cologne to an aggregate length of 20·3 kilometres (12¾ miles). Specifications, plans, and particulars are obtainable for 10 marks (10s.) from der Registrateur B, des Oberbürgermeisteramt, Köln, Germany, and tenders must be in by November 6.

Paris.—Tenders will be received by the Post and Telegraph Authorities at Rue de Grenelle 103, on November 10, for the supply of Baudot telegraphic instruments (five lots), also messengers' wallets (three lots). Application for permission to tender must be made before October 30. On November 20 tenders will be received for the supply of various parts of telegraphic instruments for the next five years. Application must be made before November 10.

Bradford.—The borough electrical engineer is prepared to receive tenders for the following meters—viz., 117 Aron meters, 86 Frager meters, 24 Edison meters, 21 Oulton and Edmondson meters. A list giving details and capacity of the above meters can be had on application to the Electricity Office, Town Hall, Bradford. Tenders are to be endorsed "Tender for Meters," and to be addressed to the Borough Electrical Engineer, Town Hall Bradford. All meters are guaranteed to be in good condition and working order.

Madrid.—The Secretary of State for Foreign Affairs has received a despatch from H.M. Chargé d'Affaires at Madrid stating that a free public competition is announced in the *Gaceta de Madrid* of September 4 for the grant of the contract for the construction and establishment of three submarine cables to join the islands of Luzon, Panay, Negros y Cebu, in the Philippine Archipelago. Tenders must be lodged within 90 days of the publication of the conditions at the Spanish Ministry of the Colonies, accompanied by a deposit of 50,000 pesetas. The particulars received can be seen at the Commercial Department of the Foreign Office between the hours of 11 and 6.

London, W.—The Great Western Railway Company require tenders for the supply from December 1 next to November 30, 1897, of telegraph instruments, telegraph apparatus, copper wire, G.P. wire, etc., telegraph ironwork and tools, telegraph drysalteries, carbons for electric light, telegraph poles, etc. Samples and patterns may be seen at Swindon from 12th to 23rd inst. on application at the office of the Stores Superintendent at Swindon. Specifications, with forms of tender, may be obtained at the offices of the Stores Superintendent at Swindon. Tenders, addressed to Mr. G. K. Mills, secretary, Paddingdon Station, London, and marked outside "Tender for Stores," will be received on or before 26th inst.

Monmouth.—The Town Council invite tenders for (1) machinery (consisting of turbines alternators, steam-engines boilers, electric motors, sewage pumps, etc); (3) cast-iron pumping main; and (4) electric lighting mains. Plans may be seen on application to Messrs. Bramwell and Harris, engineers, 5, Great George-street, Westminster, S W., or to the Town Clerk, Monmouth, from either of whom may be obtained on deposit of £2 2s. (to be returned on receipt of a bona fide tender), a printed form of specification and tender for either contract. Tenders, on the prescribed form, must be delivered with the specification attached (enclosed in a sealed envelope), endorsed "Sewage-Disposal, Tender for Contract No. —," and addressed to Mr. T. R. Oakley, town clerk, Monmouth, by 12 noon on November 2.

London, E.C.—Tenders will be received until 10 a.m. on 26th inst (*a*) for the supply of red fir telegraph poles, to be delivered in London, King's Lynn, or Sutton Bridge, and at Northumberland Dock (River Tyne), West Hartlepool, Hull, or Grimsby; and (*b*) for creosoting the poles with 10lb. or 12lb. of creosote to the cubic foot, as may be directed, for the Postmaster General. The poles to be felled between November 2, 1896, and March 1 1897, and to be delivered during the following summer at the port at which the creosoting is to be performed. Butt-sections, from not less than three poles to show the quality of timber offered, must precede or accompany the tender of any person who has not already supplied the Postmaster-General with poles. Forms of tender, containing all particulars, may be obtained on application to Mr. Chas. E. Stuart, controller of stores, General Post Office, E C.

Torquay.—The Town Council require tenders for the supply and erection of the following plant: (Section A) boiler-house plant—boilers and fittings, forced-draught apparatus, feed storage, etc; (B) engine house plant—steam alternators, condensers, pumps, steam and exhaust pipes, etc.,; (C) switchboard, etc.; (D) underground mains, lamp-posts, etc.; (E) transformers, etc; (F) meters; (G) accumulators, etc.; (H) crane, etc.; (I) builder. Tenderers are at liberty to tender for any section or sections, but not for part of a section. Specification, with terms and conditions of tender and contract, may be obtained of Mr. W. H. Trentham, consulting engineer to the Council, 39, Victoria-street, Westminster, S.W., or of Mr. Fredk. S. Hex, town clerk, Town Hall, Torquay, on payment of £3. 3s., which sum will be returned on receipt of a bona fide tender. Tenders must be addressed to the Town Clerk, sealed and marked "Tender for Electricity Works," and delivered by 3 p.m. on November 3.

RESULTS OF TENDERS.

Belfast.—The tender of Messrs. Wm. Coates and Son, of Belfast, has been accepted, at £3,210, for supplying a complete electric lighting installation to the asylum, for the Governors of the County Antrim Asylums Board.

Walsall.—The tender of Mr. W. Wistance for putting in the brickwork required for the boiler at the generating station and the foundations of the transformer at St George's Hall, for the sum of £99. 10s., has been accepted by the Town Council.

Bath.—The Corporation have accepted the following contracts: Electric Construction Company, boiler-house plant (Babcock boilers), £2,462, engine-house plant (flywheel alternators), £8,364; Callender's Cable and Construction Company, underground works, (cables), £7,985; Electric Construction Company, converters, £470; Stothert and Pitt, overhead travelling crane, £350—total £19,631. The tenders for the arc lamps and posts are still under consideration.

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BUSINESS NOTES.

Cheltenham.—Cambray Chapel has been fitted with the electric light.

Howden.—The inhabitants are agitating for a telephone call office to be opened in the town.

Colchester.—Arrangements have been made for lighting the new military hospital with electricity.

Leatherhead.—The General Purposes Committee reported at the meeting of the Urban Council that they had adjourned the electric lighting question for further discussion.

Battersea.—At a meeting of the Vestry a letter was received from Mr. W. D. Young, solicitor, notifying the Queen's assent to an Act confirming the Battersea electric lighting provisional order.

Change of Address.—Messrs. Alex. Shanks and Son, Limited, engineers, have removed their office address from 110, Cannon-street, London, E.C., to Bush-lane House, Bush-lane, Cannon-street.

The Rontgen Rays.—Mr. Edward P. Thompson, of 5, Beekman-street, New York, has received a letter from Dr. Röntgen thanking him for a copy of his book on "X Rays," which he had read with great interest.

London and Lancashire Fire Insurance Company.— The directors have declared an interim dividend of 3s. per share (being at the same rate as the last interim dividend) payable on November 5 1896.

Catalogue.—We have received from Mr. Archibald J. Wright, electrical engineer and manufacturer, 70 Farringdon-road, London, E.C., a comprehensive illustrated price list of electric bells, indicators, batteries, etc.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending October 18 amounted to £1,081, as compared with £1 104 in the corresponding week of the previous year, being a decrease of £23.

New Company.—The Simon Carves By-Product Coke Oven Construction and Working Company, Limited, which has just been registered, also take powers to construct electric works in addition to the works indicated in the title.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ending October 16 were £2,108. 2s. 10d., compared with £2 007. 14s. for the corresponding period of last year, being an increase of £100. 8s. 10d.

The Law Courts, London.—During the Long Vacation the electric light has been fitted up in all the judges' rooms and corridors, and each apartment is now supplied with an electrolier containing the most modern improvements.

York.—The committee who protest against electric lighting by means of municipal capital or under corporation control have issued a circular to each candidate at the ensuing municipal elections asking definitely for his views on the matter.

New Publication.—We have just received from Messrs. Longman and Co. a copy of "Examples in Electrical Engineering," by Samuel Joyce, A.I E.E., which is published at 5s. A fuller notice of this work will appear in a subsequent issue.

West Hartlepool—As a result of the installation of electric driving-plant, and the use of a separate motor to each machine, the coal consumption at Sir William Gray's shipyard is said to have been reduced from 72 tons to 38 tons per week.

St. James's and Pall Mall Electric Light Company.—The sale of electricity for the quarter ending September 29, representing the supply at 6d. per unit, amounted to £10,084, as against £7,402 at the same rate for the corresponding period of 1895.

Bridgwater.—The question of the rearrangement of the lamps in High-street came up at the Town Council meeting and it was stated that that would be held over until they had the report as to the electric light. The new committee would be appointed on November 9.

Rathmines.—The Commissioners have been discussing the advisability of promoting a Bill in Parliament with the object of enabling the municipal body to construct tramways, to purchase existing tramways, to borrow money, etc. The meeting was adjourned till to day (Friday).

City and South London Railway.—The returns for the week ended October 18 were £1,012, compared with £927 for the corresponding period of last year, being an increase of £85. The total receipts for the half-year 1896 were £14,693, compared with £13,701 last year, being an increase of £992.

Newmarket.—At a special meeting of the Urban District Council, held on Wednesday evening, it was agreed to make application to the Board of Trade for a provisional order to supply electricity for public and private purposes in Newmarket. Eight voted for the motion and three against.

Kensington.—The Vestry have agreed to the following applications relative to the extensions of their mains in this parish—viz., Notting Hill Electric Lighting Company, Church-street and Gloucester-walk; House-to-House Electric Supply Company, Cresswell-gardens and Earl's Court-road.

Oldham.—Major-General Crozier has held a Local Government Board enquiry into the application by the Corporation for power to borrow £10,000 for electric light purposes. Additional boilers with condensing plant and special water apparatus and a dynamo will cost £5,000. The buildings will also be doubled in size.

Works Additions.—Messrs. W. H. Willcox and Co. have taken the old works lately occupied by the Sphincter-Grip Company to manufacture their patent wire-bound hose. Formerly all the work had to be carried out in Dublin, but they are compelled, in order to meet the increased demand for this hose, to manufacture it in London.

West India and Panama Telegraph Company.—For the two weeks ended October 15 the receipts were £1,900, as against £2 101 for the corresponding period of 1895. The directors announce, after paying the preference dividends and placing £1,000 to reserve, the payment of a dividend of 1s. 6d. per share on the ordinary shares.

Bingley.—The chairman of the Gas Committee (Mr. J. Gatecliff) has been requested by the District Council to have an interview with Mr. Harris with respect to the proposal of the Leeds and Liverpool Canal Company to supply the district of the Council with electricity and to obtain all the necessary information of the cost of distribution.

Hartlepools Electric Tramways Company, Limited—This Company has been registered, with a capital of £50,000 in £10 shares, to adopt and carry into effect an agreement with the British Electric Traction (Pioneer) Company, Limited, to construct and work the tramways authorised by the Hartlepools Electric Tramways Order, 1895.

Fatal Accident.—Two cable operators from the Anglo-American cable station at Valentia, Ireland, were sailing in a small boat when they were struck by a squall. The boat was capsized and both were thrown into the water. One of them, named George Hutton, was drowned; the other, William Thompson was picked up in an exhausted condition.

Wolverhampton.—At the meeting of the Trades and Labour Council a circular was received from the Wolverhampton branch of the Electrical Trades Union, which numbers about 100 members, expressing a desire to become affiliated with the council. The President said they were very pleased at this and other accessions to the council which had taken place recently.

Folkestone.—The Town Clerk read a letter at the Town Council meeting from Mr. W. G. Hopkins stating that the amendments of Dr. Hopkinson with regard to the electricity scheme affected very materially the whole matter, and asking for a meeting of the committee, and suggesting that Dr. Hopkinson be asked to attend. The town clerk was instructed to call the committee.

Walsall.—The total number of consumers supplied on September 30 last was 65. The wages paid during the month amount to £32. 15s. The value of coal consumed was £20. The electrical engineer has been instructed to obtain tenders for the necessary cable for the transformers, and the Electric Lighting Committee have authorised the chairman to accept such one as he may consider advisable.

Bedminster.—A letter was read at the Parish Council meeting from the Bristol Town Council accepting the Council's terms, with certain restrictions as regarded electric lighting. Mr. Moore said that the latter was rather indefinite, and he did not think much good could be done by discussing it then, and advocated waiting for a definite reply. It was decided that the town clerk be written to for a detailed reply.

Bury St. Edmunds.—The Ratepayers' Association have not yet decided whether they will bring forward one or more candidates for the forthcoming municipal election, but it is thought likely the feeling of the ratepayers will be tested upon the electric lighting question, and that at least one strong opponent of the proposal to apply for a loan to establish public lighting by electricity will seek support at the poll.

Barnes.—At the meeting of the District Council the Finance and General Purposes Committee reported that two representatives from the County of London and Brush Provincial Electric Lighting Company attended before them respecting the Council consenting to a provisional order in the company's favour for this district, when consideration of same was adjourned until next meeting, on November 5 next.

The Mumbles Railway.—The negotiations entered into by a London syndicate to either purchase or take on lease for 21 years the Swansea and Mumbles Railway, with a view to running it by electricity, have been deferred until the end of November. It is stated that on Tuesday, October 27, three members of the syndicate will visit Swansea to further inspect the Mumbles Railway and to confer with Sir John Jones Jenkins.

Aberdeen.—At a meeting of the Watching and Lighting Committee of the Town Council, Bailie Young drew attention to the request for electric street lighting in George-street. It was resolved to hold a special meeting on an early date to consider the whole question of electric lighting of the streets, and specially as to whether lamps suspended from above the centre of the streets are preferable to the standard lamps in use in Union-street.

Burton.—The Lighting Committee have resolved that in the event of the Town Council approving and adopting the resolution of the Public Library Committee for the Burton Institute premises now used as a public library to be lighted with electricity, that Mr. Ramsden cause the necessary mains to be laid in Union-street as far as Duke-street, and thence to the infirmary for that purpose, and for affording a supply of electricity to the infirmary.

Yarmouth.—The surveyor reported at the Town Council meeting that applications had been received for 227 additional lamps for private consumers. The total number was thus increased to 9,279. The income for September amounted to £314. 3s. 4d., and the expenditure to £172. 10s. 11d., a difference of £141. 12s. 5d. The cost of capital and sundry charges was about £130 per month. The Council reduced the price of current for motors and warming to 4d. per unit.

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Lewes.—Another electric lighting scheme has been placed before the townspeople by Mr. Walker, of London, and it is considered that a good start could be made with £5,000. The estimate of the capital required for laying down the system is £10,000, which includes the provision of 4,000 8-c.p. lamps, together with the upkeep. The details of the estimate were: buildings, £1,500; machinery and plant, £4,000; laying and distributing, £4,000; contingencies, £500.

Cambridge Electric Supply Company, Limited.—The following are the quarterly returns from July 1 to September 30: Number of units sold during quarter 1896, 17,025; corresponding quarter 1895, 13,027. Revenue from electricity supply £467 15s. 10d., as compared with £354. 16s.; revenue from meter rents and other sources £62. 13s. 9d. as compared with £56 last year. The total revenue for the past quarter was £530. 9s. 7d., compared with £410. 16s. for the corresponding period last year.

City and South London Railway Extension.—The engineer for the City and South London Railway extension has submitted for the approval of the London County Council a plan of the proposed station at London Bridge. The contractors have undertaken to carry out the work without demolishing the existing building, which is situated at the corner of Denman-street and Railway-approach. The County Council committee reported the plan to be "sufficiently satisfactory," and recommended it for approval.

Ealing.—The surveyor reported at the District Council meeting that Mr. Drew Bear, one of the churchwardens, and the vicar had expressed themselves very well satisfied with the installation of electric light at St. Matthew's Church. The surveyor further reported that the number of 8 c.p. lamps actually connected with the mains was at present 9,130. He added that during the vacation he had visited a number of public electric light stations, and he thought Ealing had nothing to complain of.

Portsmouth.—It was decided at the Town Council meeting that application be made to the Board of Trade, in the ensuing session, for a provisional order authorising the Corporation to supply electricity within the added areas, and to extend the supply authorised by the Southampton Electric Lighting Order, 1895, to such added areas accordingly. The electrical engineer (Mr. J. H. Lee) was instructed to submit a report and estimate of the cost of fitting the electric light in the municipal buildings and Guildhall.

Swadlincote.—At the meeting of the Urban District Council the Water and Lighting Committee reported that they had offered the gas company £16,000 for the gas undertaking, that being their expert's valuation. In consideration of the company's refusal the committee asked the Council to light the whole district with electricity, and recommended that an expert be employed to take the matter into consideration and give an estimate of the cost. Mr. Mansfield moved the adoption of the report, and it was carried.

Ayr.—At the meeting of the Town Council the burgh electrical engineer reported that the plant and mains still continued to work most satisfactorily. The present maximum demand was 55 amperes, or 10 per cent. above the original rated output of one of the larger sets of plant. Were the town hall to be used before 7 p.m., this would rise to over 60 amperes, which was still 5 amperes below the emergency load at the present rating. The Council have decided to procure a high-speed plant of 200 kilowatts, including cables, etc., at an estimated cost of £5,000.

Darwen.—A meeting of the General Purposes Committee of the Corporation has been held to consider the report of the Electric Lighting Sub-Committee, who deemed it advisable to apply for a provisional order conferring upon the Council the right to manufacture, store, and supply electricity within the area of the borough. However, the General Purposes Committee are not yet satisfied, and after a rather prolonged discussion it was decided to defer consideration of the report until Mr. E. M. Lacey, A.M.I.C.E., should be present and explain several technicalities.

New Deer.—At a meeting of the Lighting Committee it was pointed out that the condition of the existing lanterns was not such as to warrant a continuance of their use. The committee being therefore face to face with the necessity of providing a new system of lighting considered the possibility of introducing the electric light into the village, the water power in the locality being believed to be sufficient for supplying motive power. It was resolved accordingly to communicate at once with some of the electrical firms with a view to procuring all the requisite information.

Shoreditch.—The London County Council have sanctioned the borrowing by the Vestry of £29,665 for the erection of the necessary buildings for a dust destructor and electric lighting station, consisting of a destructor-house, engine house, chimney shaft, battery, test, and pump rooms, offices, stores, and weighbridge, and to obtain the necessary boilers, fans, lifts, hoists, trucks, wagons, and other plant. The period for repayment of the buildings and plant for the dust destructor is limited to 30 and 15 years respectively, the period of 42 years being confined to the cost of the electrical installation.

St. Andrews.—A minute of the Lighting Committee was submitted at the Town Council meeting regarding the electrical lighting of the city. Dean of Guild Rutherford, the convener, stated that he had had a consultation with Mr. Arnot, electrical engineer, Glasgow, whose opinion was that there was not a town in Scotland more favourably situated (being so compactly built) for the introduction of the electric light, and that it could be introduced with great success. Owing to demands on his time at present, however, Mr. Arnot asked that the adoption of the minute might be delayed pending his report.

Ashton-on-Mersey.—At the meeting of the Urban Council, the General Purposes Committee reported that they had met deputations from the Manchester Tramways Company and the Electric Syndicate, and heard the proposed rival plans for laying down tramlines from Stretford to Peel Causeway. The proposals have already been made public, and the committee promised the promoters of both schemes that they would carefully consider them and forward a reply in due course. A letter was read from the Altrincham Electric Supply, Limited, giving notice of their intention to lay electric mains in the township.

Glasgow.—In connection with the new signal-box erected by the North British Railway Company on the bridge at Queen-street Station electric bells have been fitted up from each platform, so that those in charge of the platform can at once communicate with the signalman whenever a train is ready to start, and as to which should have the precedence. The tenth public meeting of the Glasgow and West of Scotland Enginekeepers' Association was held in the city hall a few days ago. Mr. R D. Munroe, M.I.M.E., presided, and in the course of his opening address he spoke of the improvements which had taken place in connection with motorcars and the production of electricity.

Brighton.—The work of extension at the Corporation electricity works is now nearing completion, and the accommodation will be of the most ample description. The additions at the rear include a boiler-house, engine-room, stokery, and storerooms, also messrooms and offices for the overlookers of the various departments. This portion of the work is expected to be finished by the close of the present month The operations in front, which should be completed by the end of November, consist of the addition of two floors, to be used as offices by the manager and the general staff of clerks. Illustrations of the works appeared in our issue of June 26 last. The arc lighting in New-road is being extended.

Manchester.—The following resolution was passed at the meeting of the Manchester Carriage and Tramways Company: "That the scheme for the extension of the company's tramways within the districts of Droylsden, Audenshaw, Swinton and Pendlebury, Moss Side, Stretford, Withington, Sale, Ashton-upon-Mersey, Timperley, Dunham, Altrincham, Bowdon, Hale, and Northenden be approved, and that the directors be authorised to apply in the ensuing session of Parliament for a provisional order empowering the company to construct such tramways, and to work and use the same by horse, electric, or other haulage." The resolution further authorised the borrowing of £125,000 for the purpose.

Appointments Vacant.—The Corporation of Blackpool require the services of a thoroughly capable and experienced electrician to act as mains superintendent. Salary, £2. 10s. per week. Particulars can be seen in our advertising columns.—The Worcester Electricity Committee require an "electrician-in-charge" at their electricity works, to take charge of the running plant and switchboard during an eight-hour shift each day. Applicants must have held a similar position in a high-tension alternating-current station. Salary, £90 per annum. Applications to be sent to Mr. E. T. Ruthven-Murray, city electrical engineer, Guildhall, Worcester, not later than 31st inst. Three recent testimonials are required.

Ludlow.—At the meeting of the Rural District Council the Assessment Committee asked for the Guardians' consent to appear as respondents in the name of the Guardians to an appeal to Quarter Sessions by Mr. J. B. Wood against the rating of his electric light plant, etc., and to make the necessary orders thereon. The clerk read the notice of appeal from Mr. C. B. Cottam (solicitor and agent for Mr. J. B. Wood). Mr. Edwards proposed that the Guardians sanction the defence at Quarter Sessions of the assessment made upon the property of Mr. J. B. Wood, of Henley, in connection with Henley mill and water supply and all buildings and ratable property in connection with the electric light. The motion was carried.

Bray.—Having ascertained that a considerable proportion of the traders and ratepayers are under an erroneous impression as to the nature of the proposed electric tramway line, Messrs. Molloy and Molloy have written to the papers to remove the misconception. The supposition seems to be that the proposed line of tramway is to consist of a double line of rails throughout the length of the main street and Quinsborough-road, but they point out that this is not so. The proposed line is to be single from the town hall terminus to Quinsborough-road, and from Quinsborough-road junction with the main street it will also be single. The rest of the system will only be double where it will not be an interference with the ordinary traffic.

Dundee.—A conference has taken place between ex-Lord Provost Hunter, convener of the Works Committee of Dundee Town Council; Mr. W. Mackison, burgh engineer; and Messrs. Pirie and Moir, directors of the tramway company, along with Mr. Fisher, the manager, with reference to the proposed extension of the tramway system, it having been suggested that powers should be taken under the new Corporation Bill to have extensions effected. The company, it was stated, were disposed to consider the question of the development of the districts named by means of motorcars. The burgh engineer was instructed to provide the tramway company with a plan of the lines proposed, and the probable cost of the various proposals made.

Colwyn Bay.—The surveyor submitted detailed plans, etc., at the District Council meeting of the proposed electric tramway from Colwyn Bay to Llandudno, accompanied by a letter from Messrs. Alfred Dickinson and Co., Birmingham, the engineers. Mr. John Roberts said he would like to see a light railway from Denbigh, through Bettws-y-coed to Colwyn Bay and Llandudno.

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He thought the County Councils should take that matter up. Mr. W. Davies proposed that the engineers be asked to attend a special meeting of the Council and fully discuss the whole project, and this was agreed to. On the recommendation of the Highways Committee, it was agreed that no steps be taken for the lighting of the new promenade until the cost of lighting the same by gas and electric light be ascertained.

Bath.—At a meeting of the Urban Sanitary Authority, Mr. Alderman Sturges, chairman of the Electric Lighting Committee, brought up a recommendation that the previously sanctioned application to the Local Government Board for permission to borrow £45,000 for electric lighting purposes should be increased to £58,000, the main necessity for the increase being a desire on the part of the committee to provide sufficient capital for a much larger extension of the mains than that contemplated in the original scheme. Mr. Robert Hammond, the consulting engineer of the Corporation, was present, and was called upon to explain the details of the scheme, and after a somewhat warm debate the resolution was carried by 23 votes to 7. The Local Government Board enquiry is fixed for the 30th inst.

Middlesbrough.—At the Town Council meeting Councillor F. Brewster called attention to the minute of the Streets Committee with reference to an application from the tramways company for certain alterations and extensions of the tramway system in order that the whole might be worked by electricity and inviting the members of the Council to inspect the Bristol electric tramway. He said the committee had asked for a plan and detailed explanation of their proposals, but he thought that before putting the tramway company to that expense they should accept their invitation to visit Bristol. The committee's minutes were passed. On Wednesday the members of the Corporation visited Hartlepool, where, by the courtesy of the Hartlepools Tramways Company, they inspected the electric system in vogue in those towns.

Tunbridge Wells.—Mr. A. Boot, the borough electrical engineer, has written to the *Kent and Sussex Courier* calling attention to the fact that the Corporation are now giving a continuous service, "and that pressure is maintained on the mains during the 24 hours. The committee hope that the consumers will endeavour to consume as much electric energy for heating, cooking power, or lighting purposes during the daytime as possible, and thus help them during the hours when it is unprofitable to run owing to the small demand." The meaning is clear, but it might have been more happily put, especially when there are people who are willing, and even anxious, to misunderstand, if by that means electric lighting can be discredited. There appears to be a strong public feeling in favour of lighting St. John's Church with electricity.

Stirling.—Bailie Lawson reported at the meeting of the Police Commission that he had had a conversation with Prof. Kennedy and Mr. Mackenzie, convener of the Edinburgh Lighting Committee, and he thought his committee should be authorised to take Mr. Kennedy's advice as to whether the Commissioners should erect machinery themselves and go on with the manufacture of the electric light, and what prospect of success they might hope to attain. Edinburgh showed an excellence in respect to the electric light which was not surpassed in the United Kingdom. The street lamps, he understood, only cost the ratepayers 2d. per unit. Provost Kinross said he thought the first step was to ascertain what demand there was likely to be for the electric light before incurring the expense of consulting an expert. After some discussion Bailie Lawson's suggestion to consult an expert was adopted.

Ashton.—At the meeting of the Town Council the minutes of a special meeting convened for the purpose of conferring with the directors of the British Electric (Pioneer) Company, Limited, as to the supply, by the Corporation to the company, of electrical energy for the working of the company's tramways were passed. These minutes stated that Mr. Garcke, the managing director, and Mr. Sellon, the engineer of the company, attended the meeting, and a discussion took place as to the terms and conditions upon which the Corporation would be prepared to give, and the company to take, a supply of electrical energy. Mr. Garcke expressed a general approval of the suggestions as to price and minimum supply contained in Mr. Clirehugh's report, and it was ultimately decided that the town clerk, with the assistance of Mr. Clirehugh, should prepare the draft of an agreement between the Corporation and the company, to be submitted for the approval of the committee at a subsequent meeting.

Watford.—At the Urban District Council meeting Mr. Hawtayne's report as to a scheme for electric lighting, which was submitted at a previous meeting, was considered, several questions being asked the engineer, from which it appeared that the scheme would cost something like £20,000. Councillor Benskin said he was opposed to the electric lighting, for he was of the opinion that it would be a burden to the ratepayers. He would be quite satisfied if the matter was deferred for 12 months, rather than add to the rates. He maintained that a matter involving as it did a sum of about £20,000, considering that they had committed themselves to £24,000 for works of sewerage, was worthy of their serious consideration. He felt sure that Mr. Hawtayne in estimating that 8,000 lamps would be taken up the first year was an estimate which could not be understood by the majority of the members of that Board. He proposed that the matter be deferred for 12 months, and eventually this was carried.

Useful Pocket-Books.—We have received a copy of the Electric Construction Company's price list for 1896. It is in pocket-book form, and, besides a mass of information, with prices relative to the company's various well-known manufactures, contains some useful reference tables and matter. Another feature which will make this little book of especial value is the useful character of the memoranda sheets, which are finger indexed and square-ruled. A copy of "The Practical Engineer" pocket-book for 1897 has also come to hand. This useful publication is too well known amongst electrical engineers and others to need a lengthy description of its contents; suffice it to say that the efforts of the proprietors to enlarge its scope and usefulness have in no way relaxed with the present issue. The copy before us includes a diary, and its memoranda sheets are of square ruled paper, which feature, as we have noted before, helps to make these pocket-books of exceeding utility to engineers. The publishers are the Technical Publishing Company, Limited, 31, Whitworth-street, Manchester, and the price, we may add, is 1s. 6d. net.

Newcastle.—Mr. H. Engel has just issued his first circular descriptive of the proposed electrical and general engineering exhibition to be held in this city next year, and to be opened in February next. The Corporation have passed the plans for new and special buildings to be erected on a portion of the Pandon Dene area, at the end of Northumberland-road. Messrs. Armstrong and Knowles are the architects. By the official sanction of the Board of Trade the exhibition will be an international one, and the promoters intend that it shall be the largest show of the kind ever held out of London. The exhibits are expected to illustrate, with some approach to accuracy, the changes and developments that have taken place in electrical engineering and other branches of industry since 1837—the year of the Queen's accession. The exhibits will be classified in two divisions and 14 departments. These departments will be illustrative of electricity, shipbuilding, and sea industries, mining, motorcars, mechanical industries, art furniture, and other products, sanitation, raw materials, alimentary products, horticulture, women's industries, and the fine arts.

Chelmsford.—Messrs. Crompton and Co.'s new works are rapidly approaching completion. The factory will be entirely on the ground floor, which will immensely simplify the working, and will comprise a block of main shops 260ft. by 150ft., shut off from which by iron doors is a store 140ft. by 20ft. The boiler economiser house measures, with the coal-bunkers, 70ft. by 50ft. All the buildings are arranged so that they can be easily extended if required. The water supply will be from tube wells sunk on the site, and there will be a storage reservoir on the ground holding 160,000 gallons. The office block measures 156ft. by 32ft., and is faced with picked stocks and red-brick dressings. The factory buildings were principally designed by Mr. Brunton, the works manager, and the office block by Mr. John Slater, F.R.I.B.A., of 46, Berners-street, London, who also acts as consulting architect for the whole of the work. The contractors are—for the main factory buildings, Mr. J. Bray, of Yarmouth; for the chimney shaft and offices, Mr. Frank Johnson, of Chelmsford; and for the iron and steel work, Messrs. Dorman, Long, and Co. Mr. H. F. Sheppard is clerk of the works.

Croydon.—The Lighting Committee of the Town Council in their report stated that the Electric Light Sub-Committee reported that the British Thomson-Houston Company, Limited, had requested to be allowed to substitute the security of the Comptoir National d'Escompte de Paris in lieu of the guarantee fund as provided for in the contract. The sub-committee suggested that, subject to the execution of a bond to be approved of by the town clerk, the proposed substituted guarantee be accepted, the present moneys in the guaranteed fund to be paid to the contractor less a retention of 10 per cent. The committee recommended accordingly, but it was referred to the Finance Committee. Alderman Barrow asked upon what terms the Council would be prepared to bring the electric light to Park-hill. He knew some of the residents were prepared to take it, and he believed upon certain conditions it would be supplied. Alderman Miller replied that the provisional order provided that if an extension were required in an outside area, consumers, by taking a sufficient amount of current to pay 20 per cent. for three years, would be supplied, but the contractors said that they would be satisfied if sufficient were taken for 10 per cent.

Oxford.—The progress of the electric light during the past year has more than fulfilled the anticipations which were made some 12 months ago. In addition to the 200-h.p. unit of generating plant which was installed in the autumn of last year, the Oxford Electric Company are at present erecting a 600-h.p. engine and dynamo. The horse-power will then be raised from 800 to 1,400. This engine and dynamo will enable the company to add 16,000 lamps of 8 c.p. each to their mains. At this period last year some 14,000 lamps were connected to the company's mains, and to-day there are nearly 19,000. Mains have been laid during the last year in St. Margaret's-road, two extensions in the Banbury-road, Bardwell-road, New Inn Hall-street, Church-street, part of Woodstock-road, Norham-gardens, and Mansfield-road. A new transformer has been placed in High-street, another sub-station has just been equipped in North Parade-avenue for the residential parts of the city, and a third transformer is at present being placed in the vicinity of Carfax. A considerable addition to the public street-lighting has been made; instead of the 16 arc lamps which illuminated High-street and Cornmarket-street, an additional 16 have been added. The candle-power has also been raised from 1,200 c.p. to 2,000 c.p. each.

Wakefield.—At the meeting of the West Riding County Council the General Purposes Committee reported that they had accepted the offer of the City Council to supply electricity to the new offices for all purposes. Alderman Sherwood moved the adoption of the Electric Lighting Committee's minutes at the special meeting of the City Council, and said that everything in connection with the

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electric lighting scheme was progressing very satisfactorily. Up to the present time, about half a mile of the cable had been laid, and they had excavated about 25ft. down for the chimney shaft. though in the operations they were meeting with more water than was expected, having to take out about 57 000 gallons per hour, which was a very great difficulty. The clerk of the works had informed him that they expected to commence putting in the concrete foundations in a fortnight. The season had undoubtedly been a very wet one, and they had had very great difficulties to contend with at the works. He had been down to them that afternoon, when he learned that the whole of the boilers and everything in connection with the plant could be put down on the spot within a month. The engines, from Leeds, were ready, the foundations were being put in, and in all probability—in fact, he believed without doubt—they would have the electric light by August 1 next.

Cromer.—Mr. Broadhurst had given notice that he would call attention at the Urban District Council meeting to the question of electric lighting for the town, the object of which, he declared, was to induce the Council to obtain, in the ordinary process of procedure, a provisional order for laying down and providing electric light for the town if necessary. At the present moment the inhabitants of the town had to depend on private profit and endeavour for their light and water. Some day the electric light would come there, and unless they took steps it would have to be served in the same manner as they were now served by the gas and water companies. All that he urged was that they (the ratepayers) should occupy the ground and prevent private enterprise entering. If they obtained the order they were not bound to use it. It would, however, prevent someone planting themselves down here, and getting permission from Parliament to cut up their streets, and then charge them for so doing. He moved, "That this Council, in order to protect itself against the advent of an electric light company, decides, subject to the report to be made by the clerk as to cost being satisfactory, to apply for a provisional order." Mr. Spence had very great pleasure in seconding the motion. He thought that it was certainly a step in the right direction. The motion was carried *nem. con.*

Liverpool.—At a recent meeting of the Lighting Committee of the Corporation, it was stated that they had authorised the lighting by electricity of the following streets: London-road, Lime-street, St. George's-place, Ranelagh-street, Parker-street, Clayton-square, Elliot-street, and a portion of Church-street, involving the erection of 43 lamps. The business of the Liverpool Electric Supply Company was transferred to the Corporation on July 1, at which date the equivalent number of 16 c.p. lamps connected with the supply mains was 41,500. Since that date applications had been received for a large number of lamps, and the electric light had been installed in the Municipal Buildings and St. George's Hall, and by the end of this month it was anticipated that the number of lamps connected with the supply mains would reach 48,500. After careful consideration the committee felt justified in reducing the price of electrical energy on October 1 from 7½d. to 7d. per unit, with a special rate of 4d. per unit for power purposes and for very large consumers. Meter rents had also been reduced from 24s to 12s. per annum. The new generating station in Paradise-street was approaching completion, and would be at work in the course of November. It was announced during the meeting that the Board of Trade had approved the system under which electrical energy is to be supplied.

Moss Side.—At the Urban District Council meeting the clerk, Mr. Crofton, read the minutes of a special meeting of the Council held on the 15th inst, from which it appeared that an application made on behalf of the Manchester Carriage and Tramway Company for the Council's sanction to the construction of new tramlines in Upper Chorlton-road and other roads and streets within the Council's district had been declined, "except so far as regarded a single line, with passing places, in Upper Chorlton-road, and in that case only upon certain terms and conditions." At the same meeting it was resolved that the Council should apply to the Board of Trade for a provisional order authorising them to construct and work a single-line tramway along Withington-road, from Brooks's Bar to Raby-street; also along Raby-street and other thoroughfares in the district; and a double line along Princess-road from Bradshaw-street to Claremont-road; and that the tramways company be asked to enter into an agreement as to the lease of the projected lines. It was announced that the Stretford District Council could not undertake to supply electricity outside their own township, but the clerk, Mr. Crofton, stated that he had conferred with the town clerk of Manchester, who was taking steps to insert in a Bill about to be promoted by the Corporation a clause authorising the Corporation to supply electricity to authorities outside the city.

Grimsby.—The Public Lighting Committee have resolved to purchase a new dynamo for the town hall at a cost of about £140. With regard to the provisional order, the Chairman remarked that if they were going to apply again for the provisional order to light Grimsby with electricity, it was time the business was done. The Town Clerk said an application had already been made by a private company, and he had informed them that the Corporation had a provisional order and would oppose them. He thought, however, they might risk letting the order stand over for another year. But if any application were made, he was sure the Local Government Board would say the Corporation had had their chance, and there was no reason why someone else should not come. A private company would come sooner or later, but he thought the risk might be taken another year. Another application had been made as to whether the Corporation would let the order—having their expenses paid and something over. That was an alternative the committee might also consider. It was a pity, he added, to spend more money in this way if they were not going to carry out the order very soon. Mr. Alward cautioned the Corporation and the public against losing another such opportunity as they lost in not having their own gas company. The alternative of farming the order out as the town clerk had suggested would be a bad move. Alderman Evison moved that the matter lay in abeyance for 12 months. Mr. Brown seconded this motion, and it was carried.

Birmingham.—At a meeting of the Public Works Committee the question was discussed whether sanction should be given to the proposed application by the City of Birmingham Tramways Company for a provisional order empowering the construction of certain new tramways. The general proposals of the company have already been described in our columns. Having since their last meeting made an inspection of the routes affected by the proposed order, the committee now decided that they would not recommend the Council to sanction the construction of any tramway along Broad-street, the committee being of opinion that the traffic along the route renders it unsuitable. They also decided that they could not sanction the extension of lines from John Bright-street to Colmore-row by way of Hill-street, but they would raise no objection to a connecting line between the northern and southern routes by way of Suffolk-street, Paradise-street, and Colmore-row. A connection between Colmore-row and the Birchfield and Saltley routes is also contemplated by way of Steelhouse lane. This the committee consider reasonable, provided that Steelhouse-lane is first widened. The substitution of a route to Nechells by way of Dale-end and Coleshill-street for the present horse tramway from Albert-street, along Vauxhall, also met with the approval of the committee; as likewise did a proposal of the company to shorten the route to Molesey by single lines, one outward and the other for return, along Conybere-street and Leopold-street. The Stratford-road route was also generally approved as the one for the experimental installation of overhead electric traction; but the traction question is not affected by the present proposed application for powers, and remains over for subsequent consideration.

Ipswich.—The adoption of an electric lighting scheme at last by the Town Council has produced the usual crop of letters to the local Press to prove that the electric light is always cheaper than gas; that the electric light is always dearer than gas; and that the writer wants to see his name in print. You buy your paper and you take your choice A "Contented Ratepayer" says "let those that are not contented with the present good light, do as Messrs. Cowell, Hodge, Fraser, Footman, and Co. do—instal their own, not try to make those that are quite contented with gas pay for their fads and fancies" Ipswich gas is cheap, but this is the first time the writer has heard it called good. It is understood that "each of the councillors, before going to the meeting, had a note from the Ipswich Gaslight Company stating that those who required electric light could be supplied by the company with gas-engines and dynamos, so that they could instal their own. This tardy conversion to the use of gas for electric lighting comes too late. Several shops, when the old company stopped in Ipswich, put down small gas engines and dynamos rather than be without current. One enterprising pork butcher used a gas-engine he had already there and which in the daytime works a sausage-machine. Curiously enough, his half-dozen or so lamps seem to run more steadily than in many larger installations. Messrs. Gardiner and Co, of Ipswich and Leicester, having tried various forms of gas-burner, write: "We are about to instal a gas-engine and dynamo, for we are assured we can produce the current at 3½d. per unit and thus save 2½d. per unit." They object, and not unreasonably, to some of the more sanguine comparisons between the lighting power of gas and electricity. Messrs. Pretty and Son, on the other hand, say they cannot light their establishment so cheaply with electric light. It really all depends on how you do it, and what figures you bring into the account.

Whitehaven.—The Water and Lighting Committee reported at the Town Council meeting that they had considered correspondence with reference to the Siemens contract, and resolved that, "provided Messrs. Siemens will give another three years' guarantee similar in terms to that contained in the existing contract in respect of the lead-cased cables now being put down by them, the committee will recommend the Council to bear the cost of opening the trenches for the laying of such cables." They had subsequently received a letter from Messrs. Siemens agreeing to accept this proposal. Councillor Musgrave, in moving the confirmation of the minutes, said the matter had been one of very serious anxiety to the committee, inasmuch as the amount involved in the opening of these trenches was no less than £500. The £500 would probably in the end be a capital charge, so that it would not fall heavily on the electric expenditure for the year. The three years' guarantee with the new cable would allow ample time to test it; and at the end of that period Messrs. Siemens would be in the same position as under the original contract—bound to hand over the conductors in thorough working condition. Councillor Musgrave said that while this difference between the Council and Messrs. Siemens had been in course of settlement the work had naturally been at a standstill; but it was intended to relay the whole of the public lighting cable throughout the borough that had not already been relaid. The work would be commenced immediately, if this recommendation of the committee was now passed. The engineer having reported to the Lighting Committee the result of enquiries he had made of occupiers in Duke street and Scotch-street as to the supply of current for private purposes, the committee resolved that a con-

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ductor be laid from King-street, up Duke-street to the corner of Queen-street, at an estimated cost of £100.

The South Staffordshire Tramways.—It is stated that a syndicate has been formed to take over the Black Country tramways and work them by electricity. Practically, the Black Country is served by four companies—viz., the South Staffordshire, the Dudley and Stourbridge, the Dudley, Sedgley, and Wolverhampton, and the Birmingham and Midland. The latter, so far as can be ascertained, does not come within the proposed scheme, though the line goes from Dudley to Birmingham, and passes through a good part of the West Midland district of the Black Country. These companies have not been particularly successful, financially, owing to expenses of working and cost of motor power. It is stated that the Dudley, Sedgley, and Wolverhampton Company have consented to dispose of their interests to the syndicate, who propose, in the event of the amalgamation being successful, to adopt overhead electric traction, and to have branches from the main line to Lower Gornal, Gornal Wood, Himley, Kingswinford, and Brierley Hill. It is also proposed to have a tramway laid down between Dudley, Netherton, and Old Hill, and also between the populous districts of Cradley Heath, Brierley Hill, and Dudley. It is thought that the Walsall tramways are not included in the scheme, and no official communication has as yet been received by the West Bromwich Corporation, but it is not likely that the latter body will offer any opposition, except to the electric lighting scheme of the new company, which the Corporation would want in their own hands. These various rumours are exciting a great deal of attention in the towns concerned, and the proposal to adopt electricity as the motive power meets with general approval.

Bradford.—At a meeting of the Corporation Gas and Electricity Committee it was decided to supply electric incandescent lamps to all users free of cost, the conditions being that such lamps should burn for 1,000 hours or have used 60 units during their life. This is equivalent to a reduction of about a farthing per Board of Trade unit to the consumer. The committee agreed to the opening of an exhibition of electrical appliances for cooking, motive power, and lighting in the Swan-arcade, and it was afterwards decided to institute a system of lending motors on hire. The committee further undertook to extend their mains along the Otley-road to Peel Park Hotel. At the Town Council meeting Alderman Joseph Cowgill (chairman of the Tramways, Baths, and Team Labour Committee) moved, and Mr. W. H. Barker seconded, the adoption of the minutes of that committee. From the minutes it appeared that an offer from the Simplex Electric Tramway Conduit Syndicate to work the proposed tramway to Great Horton had been declined. A deputation from the Bradford Tramways and Omnibus Company, Limited, had attended before the committee on the subject of the proposed leasing of suggested new tramways to Bolton and to Great Horton, and after discussion the deputation had promised to send in a tender for the working of such tramways. Mr. J. Hayhurst asked whether any progress had been made in the negotiations with the Bradford Tramways and Omnibus Company Limited, for leasing the proposed new lines, and whether, in the event of the negotiations collapsing, the Tramways Committee intended working the lines themselves. Alderman Cowgill said that the committee had recommended the Council, in the event of the negotiations collapsing, to obtain powers to work the lines themselves. No tender had been received from the tramways company since the interview with the deputation took place.

Messrs. Paterson and Cooper.—The public examination *in re* Paterson and Cooper has taken place before Mr. Registrar Brougham. The debtors—E. J. Paterson and C. F. Cooper—carried on business as electrical engineers, under the style of Paterson and Cooper, at the European Works, Pownall-road, Dalston, 2, Prince's-mansions, 68, Victoria-street, Westminster, and at West Regent-street, Glasgow. The statement of affairs showed liabilities £19,514, of which £9,643 are expected to rank, and the debtors estimate that they have a surplus in assets of £7,021. Mr. Paterson stated that he commenced business as an electrical engineer in 1878, and in 1882 he was joined by Cooper, who introduced £4 500 capital. At that time he had £13 500 standing to his credit. Further sums amounting to £6,600 were paid into the firm's account. During the last 10 years they had been chiefly interested in working patent processes for bleaching and disinfecting by electrolysis. They acquired a half share in the patents by paying £300 or £400 in respect of the fees. Altogether they expended about £12,000 in various ways upon the patents A company was formed to work the English patents, and contracts were entered into by the firm; but, in consequence of the work being pressed on too fast, they incurred a loss of about £5,000 over two contracts. In 1890 the French patents were sold to a French company, and the firm received certain shares, which they subsequently disposed of. They did not consider the firm to be insolvent, but the surplus disclosed in the statement of affairs was subject to the value of the patents. Their present position was entirely due to the delay in selling the patents to a company. Mr. Cooper was also briefly examined. The trustee of the estate, Mr. Edward Cecil Moore, chartered accountant, 3, Crosby-square, London, E.C., is prepared to receive tenders for the purchase of the various businesses. Details and conditions are set out at length in an advertisement in another part of this paper.

Swansea.—A meeting of the shareholders of the tramways company has been held in London, and the chairman, in his introductory speech, remarked that at all the recent meetings reference had been made to the proposed agreement between the company and the Corporation for the sale of the tramways by the former to the latter, and the lease of them by the Corporation to the company for a period of 21 years By the Act of Parliament under which they were working, and under which the tramways were constructed, the Corporation had the power to purchase them at a valuation at the expiry of 21 years from their construction; but in their Act there was a provision that the company should in such a case have the option of a lease for a corresponding period. The first 21 years had not yet expired, but it was thought desirable to anticipate the arrangement by a year or two, as the Corporation were about to obtain powers for electric lighting in the town, including motive power for the electrical working of the tramways. The change from horse traction to electrical power involved considerable expense, wires having to be fixed, motorcars provided, and the lines relaid. Under the proposed agreement the Corporation would defray these expenses with the exception of the motorcars, which would be supplied by the company, and the rent to be paid by the company to the Corporation in future would be based upon the money expended by the Corporation in purchasing the lines and equipping them for electrical traction. The purchase price was to be £32,000 for paying off the £10,400 of 5 per cent. debentures, purchasing motorcars and other purposes, any unexpended balance at the end of three years or earlier being returned to the Corporation, so as to operate in reduction of rent. With regard to rent the company were to pay the Corporation as much interest as the Corporation itself paid for borrowing the money necessary for these works, with the addition of ½ per cent. interest. In addition to that the company had to provide a sinking fund on the £32,000, or as much of that amount as was expended by them, and on any costs which might have to be incurred in widening streets for the purposes of electric traction. These payments had to be calculated on the basis of such an annual sum as would redeem the whole in 30 years, and the money expended by the Corporation in reconstructing and adapting the tramways would have to be paid for by a sinking fund which would clear off these outlays in 21 years. Other clauses provided that the company in its new lease must provide a reasonable service to the satisfaction of the Corporation. On the motion of the Chairman the preliminary agreement was approved, and the directors were empowered to take all the necessary steps for carrying it into effect.

London Lighting Extensions.—The committee of the London County Council have passed a notice, under the Electric Lighting Acts and Orders, from the County of London and Brush Provincial Electric Lighting Company, under the Wandsworth Electric Lighting Order, 1892, of intention to lay mains of high and low tension in Dalebury-road, Beechcroft-road, Brenda-road, Langroyd-road, and Glenburnie-road. The works include mains for extra high-tension current, and among the committee's conditions are: that the dimensions of the street boxes shall in no case exceed 2ft. 6in. square in plan and 2ft. deep; that the mains be laid under the footways wherever it is found practicable to do so; that the low-tension mains be placed 9in. below the underside of the paving and those of high-tension at least a foot lower; that the extra high-tension mains be kept at a distance of not less than 12in. from any other pipe, and be not connected between the stations with any other mains, but do run untapped from station to station; that separate boxes be used for the high and low tension mains respectively, and be kept entirely distinct from one another; that as an additional precaution against accident through defective insulation of the mains, each of the high-tension street boxes be provided with an inner as well as an outer cover, the inner cover being sheathed with wood or other non-conducting material, the two insulated from each other as far as practicable, and the outer cover being efficiently connected to earth; and that adequate means be taken to prevent the accumulation of gas in the boxes and conduits. A notice, dated October 9, 1896, from the same company, under the provisions of the County of London (North) Order, 1892, of intention to lay a low-tension main in Central-street, St. Luke's, was also approved. Five notices were received from the Charing Cross and Strand Electricity Supply Corporation of intention to lay mains (1) in Bow-street and Long-acre; (2) along Great Newport street into Charing Cross-road subway; (3) in Maypole-alley; (4) in James-street, Long-acre; and (5) in Upper St. Martin's-lane, West-street, around a small portion of Cambridge circus and into Charing Cross-road subway; and were approved on the usual conditions. The Notting Hill Electric Lighting Company gave notice of intention to lay mains in Gloucester-walk, and in and across Church-street, and it was approved. The committee also passed, under conditions, three notices from the City of London Electric Lighting Company of intention to lay mains (1) in Stoney-street; (2) along Bankside; (3) across Borough High-street, in Bedale-street, Green Dragon-court, and Montague close. A notice from the House-to-House Electric Light Supply Company of intention to lay high and low tension mains in Cresswell-gardens, and another from the same company of intention to lay low-tension mains in Courtfield-gardens, were passed. The committee have also passed a notice from the Vestry of St. Pancras of intention to lay mains in Francis-street, Tottenham Court-road. Notice was also received of the intention of the Hampstead Vestry to lay mains in Priory-street and Mortimer-crescent. In this case the consent of the County Council is not needed.

The London Tramways Scheme.—Consideration of the report of the Highways Committee of the London County Council, containing the proposal for the immediate sale to the Council of the whole of the undertakings within the county of London of the North Metropolitan and the London Street Tramways Companies, for a subsequent lease to the first-named company of the lines of the two companies, and also of that portion of the undertaking of

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the London Street Tramways Company which has already been purchased by the Council and leased to that company, has been postponed. The arrangement made, subject to the approval of the Council, is that the companies shall sell their tramways to the Council at £10 000 per mile for double and £5,000 per mile for single lines, and at this rate the purchase-money would amount to £437,000. To this sum, however, for the purposes of arriving at a conclusion as to whether the offer was such as the Council could accept, the committee state that there must be added the £101,798 paid for the portion (about 4¾ miles of line, with two depôts) of the London Street Company's undertaking already purchased by the Council and leased to that company. The total amount of capital expenditure for lines and the two depôts would therefore be about £540,000. Provision has also been made for the purchase by the Council of the companies' freehold and leasehold buildings used in connection with the lines to be purchased and for the leasing company to pay by way of rent during the term of the lease (which is to be for 14 years) a sum equivalent to 5 per cent. on the amount to be paid for the freehold depôts and stables, and 6 per cent. on that to be paid for the leasehold, and, as regards the latter, that the ground and other rents which are now paid by the company shall continue so to be paid. No agreement has been come to as to the price to be paid for the buildings, but arrangements have been made for that matter to be settled by arbitration. The committee point out that the proposed arrangement is such as in their opinion the Council should accept, and that it was fair both to the Council and the company. The committee further state that they have considered the question of the advisability of the adoption of some system of electrical or other mechanical traction in substitution for horse traction and have arranged with the company that if at any time during the continuance of the lease the Council should consider it desirable that some form of electrical or other mechanical traction should be adopted the leasing company will be prepared either to carry out the necessary works on terms to be arranged with the Council, or, should the Council itself execute the works, to pay a fixed rent and a share of the extra profits which may be derived from the use of such traction. They were unable to give the Council information of a reliable character as to the probable profit to the ratepayers on the basis of electric traction, as they had as yet been unable to obtain trustworthy data on the subject. In the opinion of the engineer the conditions are so different in London, and in different parts of London, from those which obtained in any other city where electric traction was in use, that it was impossible to estimate with any approach to reliability, what might be the results of its adoption. The only really satisfactory course appeared to them to be that they should institute an exhaustive enquiry into the several systems; and, when convinced that any one possessed merits sufficient to justify the belief that it would be more economical as well as more convenient than the present system, to make a practical trial of it for a sufficient period over a typical portion of the London streets.

Blackburn.—The approaching introduction of electric tramways into the town marks the first step towards the adoption of methods that must exercise a great influence upon municipal enterprise; for the local authority proposes, not only to furnish current for operating the two electric lines from the municipal electricity works, but will also take in hand the erection of all overhead wires, poles, and other structures, as well as the bonding of rails, laying of feeders, etc. The tramway company will provide its own rolling-stock and motor equipments, receiving from the Corporation an extended lease of the lines. The important questions of maintenance—as regards the circuits (outgoing and return) and the rolling-stock—are, however, not yet settled, being matters that fall for treatment in the agreement now, we understand, in process of drafting between the Corporation and the tramway company. Considerable interest will be felt in the final arrangements made for electric traction in this town between the Corporation and tramway company, as conditions of a similar nature have not yet arisen anywhere else; indeed, Blackburn will for that matter occupy the position of being the first town in the country to operate tramways from the municipal lighting works. Mr. J. G. W. Aldridge (with whom is Mr. Frank B. Lea, lately resident engineer on the Rouen electric tramways) is advising the tramway company, whilst Mr. E. M. Lacey acts as consulting engineer to the Corporation. Colonel W. Langton Coke, M.I.C.E., an inspector of the Local Government Board, held an enquiry last week into the application of the Town Council for sanction to borrow £28,000 for electric light purposes and £10,000 for electric traction. The Town Clerk observed that in February last year the electric station at the No. 1 gasworks was opened, and application was made to the Local Government Board for permission to borrow £32,000. Prior to making the present application, the Corporation had spent £27,659 of the original borrowing powers. In April last it was decided to apply for further borrowing powers. Since the application was made the Corporation had let some contracts, otherwise they would not have been able to go on with the works this winter. Of the £28,000, £3,000 would not be spent at present, but would be reserved for further extensions. The existing buildings used now for the gasworks shops will be used for the electric light extensions. The following figures showing the increase in consumption of electricity were submitted by the town clerk: commencement of supply, February 18, 1895—number of lamps connected, 3,129; maximum load, kilowatts, 32. Ten months ending December, 1895—number of lamps connected, 5,915; maximum load, kilowatts, 121; percentage of increase, 266. Year ending December, 1896—number of lamps connected, 13,000 (estimated); maximum load, kilowatts, 325 (estimated); percentage of increase, 168. Year ending December, 1897—number of lamps connected, 20,000; maximum load, kilowatts, 754; percentage of increase, 132. In the course of the second enquiry it was stated by the town clerk that it was a matter which had been very carefully considered by the Corporation and the tramways company. The tramways had been laid by the Corporation, under the powers of the Blackburn Improvement Act, 1882, and were leased by the Corporation to the company under an indenture of lease dated June 1, 1891, for a term of 21 years. The proposition was to supersede the two horse sections only with electric traction, the overhead system being proposed. They had made arrangements with the tramways company to pay the Corporation a certain price per unit, whilst the basis of cost to the company was 3d. per car mile for power only.

Telephones in Scotland.—At the statutory meeting of the Fife County Council, Mr. H. V. Haig, in moving the approval of the minutes of the Road Board, said they had arranged with the Telephone Company that the county should get the use of five instruments, as at present, on the same terms for the next three months, and they would be able to communicate along the trunk lines at 3d. per message. The Telephone Committee had come to the conclusion that the judicious thing for the county was to have a telephone system of their own. They reluctantly felt that they were obliged to ask the County Council to move in this matter, because, to begin with, the facilities that the Post Office gave were so inferior that they were practically of no use to the police, who were the principal people to use them. If the county put up this system, they would have thoroughly efficient communication with each of the police stations in connection with Cupar. It would be thoroughly private and in no way public. They had two estimates of about £1,300 each for the instruments, and they would require a skilled man at 25s. or 28s a week to attend to them. The total cost, estimated at about £2 000, could be borrowed at 6 per cent., and paid off at about £220 a year. This would give them a telephone system over 82 miles, and connecting 17 stations, for £200 a year. For that sum they would have a most efficient telephone system all over the county. They might have communication with Dundee over the Tay Bridge and with Edinburgh over the Forth Bridge. He moved that the committee be empowered to get the fullest information as to cost, etc., of a telephone system. Mr. M'Gavin Greig asked if he might be permitted to speak to a point of order. The County Council were now meeting as the Road Board, and he could take no part in their discussions, Tayport having their own roads, and not contributing to the road assessment, but the adopting a telephone system was a question for the County Council, and police burghs would be assessed, and it should be discussed at a County Council meeting, where he might, if he wished, express his view of the proposal. The Chairman said that at present they were merely considering the question generally, and no step was being taken which would commit the county to expenditure. The whole question would come up at another meeting of the County Council. Mr. W. Meiklejohn seconded the motion. Mr. Haig stated that he had calculated the expense of maintenance and renewal. The Chairman said he was now in favour of the scheme, although he was distinctly opposed to it at first. Even yet if the Post Office would treat them in a fair way he would be inclined to stand by them. If the proposed system had great advantages inside of the county, it had great disadvantages outside. The Government had distinctly refused to be reasonable in the matter, and he was now a convert to the system. Mr. Prentice asked if Mr. Haig had any idea whether or not such a proposal would be considered by neighbouring counties. Mr. Haig replied that Captain Bremner had informed him that Kinross would also join with them, and he saw no reason why they should not get communication with Dundee. Mr. Glass wanted them to be sure that they had the right to erect a telephone system before they incurred any expense. The Chairman said there was no doubt they had the right, so long as they did not charge for messages. He was advised that there was no doubt about their right. In reply to Mr. Prentice, Mr. Haig stated that the rate of way-leave for the Telephone Company's branch lines had not been fixed, but the committee were of opinion they were entitled to something substantial considering what they charged their subscribers. Mr. Glass remarked that if the system were to be a success there was no doubt that other counties would do the same. He understood it would represent a saving of £300 or £400 per year. The Chairman thought that they might save a couple of hundred per year. The motion was unanimously agreed to. At the meeting of the Glasgow Chamber of Commerce Mr D. M. Stevenson moved: "(1) That a committee be appointed to wait upon the Town Council and press upon them the urgent need of securing the telephone license for which the Corporation have applied to the Postmaster-General, with a view to the establishment of an improved service; and (2) that a memorial be sent to the Postmaster-General supporting the Corporation's application for a license, and urging a revision of the present exorbitant trunk-line tariff." After a rather warm discussion Bailie Alexander said that if Mr. Stevenson would confine his motion to the part which advocated the sending of a memorial to the Postmaster General in support of the Corporation's application for a license, he would agree. The Corporation, he pointed out, applied for a license three years ago, and no reply had been received from Government. He believed that if the twin-wire system were adopted there would be three times the number of subscribers there were at present, and the charge would be reduced to half. Mr. Stevenson said he would accept Bailie Alexander's amendment. Bailie Alexander then seconded the motion in its altered form. On a division 10 voted for the motion and 11 for the previous question.

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PROVISIONAL PATENTS, 1896.

OCTOBER 12.

22571. **Incandescent elect·ic light decorations.** Alexander Abercrombie Po'lock, 70, Wellington-street, Glasgow.

22584. **Improvements in wall sockets for electric lighting and like fittings.** Gustav Byng, 73, St. Stephen's-road, Upton Park, London.

22585 **Improvements in fittings for electric light and like purposes.** Gustav Byng, 73, St. Stephen's-road, Upton Park, London.

22595. **Improvements in electric accumulators.** Anthony George New, Palace-chambers Westminster, London.

22599. **Improvements in dynamo-electric machines.** Valere Alfred Fynn, 47, Lincoln's-inn-fields, London.

22600. **Improved method of and means for electrically connecting railway rails.** George Haskell Scott, 55, Chancery-lane, London

22633. **A high-speed dynamo.** Hans Carl Madsen, 1. Queen Victoria-street, London. (Complete specification.)

OCTOBER 13.

22661. **Improvements in electrical bell pushes or their equivalents.** Robert Bell and William Thomas Hall, Fleet-street, London.

22691. **Improved high-insulation cord grip ceiling rose.** Frederick William Heaton and Harry Smith, Salford Switch Works, Sidney-street, Salford, Manchester.

22703. **Improvements relating to the generation of gas and electricity and to apparatus therefor and the application thereof to motive power purposes.** Sidney Howe Short, 45 Southampton-buildings, Chancery lane, London. (Complete specification.)

22704. **Improvements in electric brakes.** Henry Harris Lake, 45 Southampton-buildings Chancery-lane, London. (Elmer Ambrose Sperry, United States) (Complete specification.)

22744. **Improvements in or relating to switches for electric batteries.** William Turner, 111, Hatton-garden, London.

22746. **Improvements in or connected with automatic switches for controlling electric lamps.** William James Davy, 40, Chancery lane, London.

OCTOBER 14.

22783. **Improvements in electric locking and block apparatus on railways.** Frederick Thomas Hollins, Saltley House, Forest Drive, Leytonstone, Essex.

22796. **Improvements in and relating to electrical indicators.** Mervyn Walter Stikeman and Reginald Page Wilson, 70, Chancery-lane, London.

22820. **Improved method of constructing, mounting, and arranging the underframe and driving appliances of electric and other motorcars, and in means or apparatus for reducing vibrations and oscillations and to facilitate ease of action in starting such cars.** Hazelwood Carmont, 166, Fleet-street, London.

22833. **Improved means or appliances connected with electric arc lamps.** John Henry Rose, 166, Fleet street, London.

OCTOBER 15.

22844. **Improvements in electric arc lamps for projection.** Eugen Kiupathy 3, Fleet-street, London.

22886. **Improvements in electric railways.** Nigel Harrington Balfour and Edward Wythe Smith, 66, College street, Chelsea, London.

22893. **High-voltage electric incandescent lamp.** Frederick James Satchwell, 4, Crescent-villas, Crescent-road, South Woodford Essex.

22926. **Improvements in electrical devices and in insulating supports for same.** Reginald William James 1, Queen Victoria-street, London. (William White and John Hubert Davies, South African Republic.)

22947. **An improved electrical joint.** Alfred Francis Bilderbeck Gomess, 9, Warwick-court, Gray's-inn, London.

OCTOBER 16.

22967. **An improved method of connecting electric wires.** William Henry Dorman, The Green Hall, Stafford.

22979. **Improvements in machines for covering electric or other wires or cables.** William Alfred Phillips, Market-place, Huddersfield.

22980. **A new or improved method and means for fireproofing insulated wires and cables.** William Alfred Phillips, Market-place, Huddersfield.

22990. **Improvements in appliances for the intercommunication of telephones.** Joseph Devonport Finny Andrews, 45, Fulham Park-gardens, London.

23003. **Improvements in or relating to cooking or similar stoves applicable for the production of steam for use in the generation of electricity.** Alfred Julius Boult, 111, Hatton-garden, London. (Joseph Plantard, Louis Rault, and Guillard-Dupard, France.)

OCTOBER 17.

23071. **Improvements in switches for electric currents.** John Joseph Rawlings and William Robert Rawlings, 82, Gloucester-road, South Kensington, London. (Complete specification.)

23040. **Improvements in the construction of electrical accumulators and primary cells.** Andrew George Adamson, 154, St. Vincent-street, Glasgow

23084. **An improved cell for controlling the direction of flow of electric currents or retarding such flow and for like purposes.** William Phillips Thompson, 6, Lord-street, Liverpool. (Leo Grä'z, Germany.)

SPECIFICATIONS PUBLISHED.

1895.

17745. **Electrolytic or galvanic processes or cells.** Lake. (Hoepfner)

17788. **Electromotors.** Clerk. (Lacy, Johnson, and Slacke.)

17790. **Electromagnets and method of winding the same.** Clerk. (Lacy, Johnson, and Slacke.)

17791. **Dynamos.** Clerk. (Lacy, Johnson, and Slacke.)

18440. **Arc lamps.** Hill.

19934. **Process and apparatus for the electrolytic production of metallic zinc and metallic copper from zinc ores containing copper, and oxygen gas as a by-product.** Burghardt and Rigg.

19989. **Electrical "tell-tale" or watchman's recorder.** Fletcher.

20843. **Electric batteries.** Shrewsbury, Marshall, and Dobell.

21137. **Electrical tramway and railway conductors.** Nisbett.

22207. **Electrodes suitable for electrolytic apparatus.** Kellner.

22246. **Insulators and insulating conduits or tubing for electrical purposes.** Treharne.

22519. **Electric railways or electric transport.** Esmond. (Date applied for under International Convention, April 26, 1895.)

1896.

3151. **Arc lamps.** Schmidt and Schmidt.

10788. **Electric arc lamps.** Bagnall.

15013. **Electrical selectors and answer-backs.** McKenna. (Drysdale.)

15622. **Alternating-current dynamo-electric machines.** Little.

19303. **Electromagnets.** McKenna. (Electric Selector and Signal Company)

19304. **Ele tric selectors and adaptations thereof and transmitters suitable therefor.** McKenna. (Electric Selector and Signal Company.)

19305. **Electrical selecting instruments.** McKenna. (Drysdale.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	8½-9
Brush Company, Ordinary	3	⅞-1⅛
—— Non. Cum., 6 per cent. Pref.	2	1⅛-1⅜
—— 4½ per cent. Debenture Stock	100	110-113
Central London Railway, Ordinary	10	10-10½
——	2	4⅛-4⅜
Charing Cross and Strand	5	9½-10
Chelsea Electricity Company	5	7¾-8¼
—— 4½ per cent. Debentures	100	114-117
City of London, Ordinary	10	16-17
—— 6 per cent. Cumulative Pref.	10	17-18
—— 5 per cent. Debenture Stock	100	131-135
City and South London Railway, Consolidated Ordinary	100	50-52
—— 4 per cent. Debenture Stock	100	137-139
—— 5 per cent. Pref. Shares	10	14¾-15¼
County of London and Brush Provincial Co., Ordinary	10	8¾-9¼
—— 6 per cent. Cum. Pref.	10	13¾-14¼
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
Edison and Swan United Ordinary	3	1¾-2¼
—— 4½ per cent. Debentures	100	103-106
Electric Construction, Limited	2	1⅛-1⅜
—— 7 per cent. Cumulative Pref.	2	2½-3
Elmore's Copper Depositing	2	⅛-⅜
Elmore's Wire Company	2	¼-½
W. T. Henley's Telegraph Works, Ordinary	10	17½-18½
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	3¾-4¼
—— 7 per cent. Preference	5	8¾-9¼
India Rubber and Gutta Percha Works	10	21½-22½
—— 4½ per cent. Debentures	100	105-108
Kensington and Knightsbridge Ordinary	5	9½-10
—— 6 per cent. Pref.	5	8¼-8¾
Liverpool Electric Supply, Ordinary	5	8-8½
Liverpool Overhead Railway	10	13⅛-13⅜
—— 5 per cent. Pref.	10	17⅛-17⅜
—— 4 per cent. Mortgage Debentures of £100	100	112½-114½
London Electric Supply	5	⅞-1⅛
Metropolitan Electric Supply	10	13-14 xd
—— 4½ per cent. First Mortgage Debenture Stock	100	121-124
National Telephone, Ordinary	5	7¼-7½
—— 6 per cent. Cum. First Pref.	10	17-19
—— 6 per cent. Cum. Second Pref.	10	17-19
—— 5 per cent. Non. Cum. Third Pref.	5	6¾-7
—— 3½ per cent. Deb. Stock	100	106-109
Notting Hill Company	10	11½-12½
Oriental, Limited, £1 shares	1	1⅞-2
—— £5 Shares	5	8½-9
—— £4½ shares	4½	7½-7¾
Oriental Telephone and Electric Company	1	¾-⅞
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	103-105
Southampton Electric Company	5	4¾-5¼
St. James's and Pall Mall, Ordinary	5	11½-12½
—— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	39-42
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	—	7¾-8¼
Westminster Electric Supply, Ordinary	5	10½-11½
Yorkshire House-to-House		7½-8

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NOTES.

One More Objection.—Mr. Diatto, who we believe to be an Italian, and know to be an advocate of conduit traction systems, says that to the French the overhead system carries its own condemnation. Apparently they do not distinguish between *trolley* and *trop-laid.*

Berlin Exhibition.—The *Berliner Tageblatt* estimates the deficit on the exhibition to amount to something like £390,000, and this in spite of the fact that, according to the *Local Anzeiger*, the exhibition before it closed on the 15th inst. was visited by 3,500,000 paying visitors.

Mayor of Cambridge.—Mr. Horace Darwin, a son of the late Charles Darwin, has consented to take the office of Mayor of Cambridge. It is to be presumed that this is part of the healing of the immemorial feud of town and gown which is supposed to have been in progress lately.

Italian Electrical Engineers.—Some details are given in *L'Elettricità* of the new Association of Italian Electrical Engineers. The society is to be a federation of branches in the principal towns, the head-quarters being the branch to which the president for the time being belongs. Prof. Ferraris, of Turin, is suggested for the first president.

The Turbines at Niagara.—According to a note in the *Engineer*, the friction of the 5,000-h.p. turbines at Niagara is said to be so small that when once started they will run light with a gate opening of $\frac{1}{16}$in. only. Careful experiments have shown the wheels to have an efficiency of 80 per cent., which is 5 per cent. in excess of the guarantee.

Cobalt and Nickel.—It would appear from *Wiedemann's Annalen* that it has been discovered by G. S. Mayer that in cobalt and nickel tension produces an E.M.F. identical in direction with that produced by longitudinal magnetisation. So far as permeability is concerned, the behaviour of cobalt under stress appears to be similar to that of iron.

Dundee Architects.—We have received the annual report of the Dundee Institute of Architecture, Science, and Art, and a circular in which the council of the institute announce that preliminary arrangements have been made for the opening meeting of the session to be held on or about November 5 next. The probable dates of other meetings of the session will be December 17 and March 18.

The Behr Railway.—The ceremony of turning the first sod of the single-line electric railway at Tervueren, adjoining the grounds of the Brussels Exhibition, has taken place. This is a "single rail" system on trestles, of which the inventor and patentee is Mr. F. Behr. It was fully described and illustrated in our columns some time ago, and the Brussels line will be the first occasion of it being tried on a practical scale.

Liverpool Engineering Society.—The following is the list of papers to be read up to Christmas: November 11, 1896, Mr. G. L. Burton, A.M.I.C.E., "Water-Tube Boilers"; November 25, 1896, Mr. Ernest S. Wilcox, M.I.C.E., "Some Notes on Railway Construction"; December 9, 1896, Mr. James Glover, jun., M.A., A.M.I.C.E., "Some Notes on Current Specifications and Tenders for Public Works." There is to be a paper by Mr. T. M. Bigley on "Electric Tramways" in February.

Meteorological Congress.—There has been an international congress of meteorologists at Paris. It appears to have been mostly confined to French and Germans. The subjects of atmospheric electricity and terrestrial magnetism were discussed, but nothing very important was brought out. It was stated that the instruments for measuring the atmospheric potential at the top of the Eiffel Tower had been working most satisfactorily in spite of the fact that the difference of potentials measured (between the air and earth) might amount to several thousand volts.

Magnetic Elements. — An abstract is given in *L'Elettricità* (Milan) of the communication made by Dr. G. Folgheraiter to the Reale Accademia dei Lincei on the possibility of obtaining a knowledge of the direction of terrestrial magnetism in classical or even earlier times. It depends upon the fact that with many kinds of clay there are traces of magnetism which are permanent, and depend on the direction of the object (a vase or brick) with regard to the earth's field at the time of firing. But it is just in the difficulty of determining this that the trouble comes in.

Some Coming Events.—There is an Electro-Harmonic Concert to-night (Friday); we gave the programme last week.—The Brush Company's meeting (confirmatory to reduce capital) will be held at the Cannon-street Hotel on Monday, November 2, at 12 o'clock.—The Society of Engineers meet on Monday next, the Civil Engineers on Tuesday, the Mechanical Engineers on Wednesday and Thursday, and the Junior Engineers on Friday. The business to be done is given in another note. The Crystal Palace Wednesday lecture is by Mr. Fletcher (once of the *Daily Chronicle*) on "The Newspaper Press."

Lucium.—It is stated that yet another "rare" metal has been discovered in monazite sand. At one time this would have been of no importance whatever to practical people. But the new element is said to make excellent incandescent mantles, and on the principle that it is impossible to specify the nameless or describe the undiscovered, it has been suggested as possible that the new metal may prove a means of circumventing the Welsbach patents. The name of the new element is lucium, and its atomic weight is put at 104. That figure is almost certainly wrong, but there is room for an element at about 99 or 100.

High-Velocity Motors.—According to the *American Engineer*, at least one large firm manufacturing dynamos and motors in the States is at work upon a motor that will run at a speed of 10,000 revolutions per minute, and if constructed is to be used by the United States Government on men-of-war to start the propelling machinery of Howell torpedoes just before they are fired from their tubes. This torpedo is propelled by the energy stored in a small flywheel inside of it, made to revolve at a speed of 10,000 revolutions, and at present a steam-turbine is the only motor of simple form that is available to rotate the flywheel at that speed.

City and Guilds Institute.—The following are the scholarships awarded in connection with the present session 1896-97 of the Central Technical College, Exhibition-road, S.W.: Clothworkers' Scholarship, £60 a year, with free education for two years, L. P. Wilson; Mitchell Scholarship, £40 a year, with free education for two years, R. S. Potter; Clothworkers' Technical Scholarship, £30 a year, with free education for two years, E. W. Cook; David Salomons Scholarship, £50, E. W. Marchant; John Samuel Scholarship, £30, H. W. Hanbury; Institute's Scholarships, free education for three years: F. S. Miller, J. I. Hunter, and F. W. Fawdry.

The Fritsche Dynamo.—In the *Elektrotechnische Anzeiger* there is a description of the bell armature dynamo which has been patented by Fritsche and Pischon, of Berlin. The machine is intended to run either as a motor or a dynamo. It is a three-pole machine, the field magnets taking the form of a double bell with slots. The armature revolves between the two slotted bells, and the commutator naturally is placed on the side of the machine corresponding to the top of the armature or the mouth of the field magnets. This form of dynamo is said to be constructed

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for outputs of between 1 and 55 kilowatts, and wound for voltages of from 65 to 240.

Self-Propelled Traffic Association. — At the inaugural meeting of the Liverpool centre of the Self-Propelled Traffic Association Lord Derby (Lord Mayor of Liverpool) presided, and Sir David Salomons delivered an interesting address. Sir David thought the immediate future of motorcarts would be in connection with trade. He did not think oil motorcarts would be popular in the long run; steam was better. "I can picture to myself," Sir David said, "that in the next 10 or perhaps five years the whole of the heavy traffic as well as the public conveyances of this country will be propelled by motors, probably steam, instead of by living horse power."

Electrolytic Gold Winning.—At the annual meeting of the shareholders of the Rand Central Ore Reduction Company, held at Johannesburg, Mr. C. S. Goldmann, the chairman, in the course of his speech, remarked that the company had been the first to practically demonstrate that slimes which had hitherto been considered unworkable could be profitably treated with the aid of the Siemens-Halske process, and much of their success was due to it. This process did not depend or rely upon chemical reaction. It was not necessary to add further chemicals to the solutions in order to get correct precipitation or better results. The simple application of the electric current was all that was necessary.

Lightning Conductors.—More attention appears to be given to the proper arrangement of lightning conductors on the Continent than in this country, possibly because thunderstorms are a little more severe there. There has been published in the *Centralblatt der Bauverwaltung* an account of a large body of observations on the subject. In the conclusions arrived at, however, there is nothing very new. They amount to this: that care should be taken to secure good and deep earths, that neighbouring masses of metal should be connected to earth but not to the lightning conductor, and that when all is said and done the best ordinary lightning conductor seems to afford no certain protection against induction strokes.

Glow-Lamp Tests.—The *Elektrotechnische Zeitschrift* in its "Review" refers to Mr. Preece's method of testing incandescent electric lamps and the results set forth in his paper at the British Association. Our Berlin contemporary is at present disinclined to accept the test as absolutely reliable until it has had a more prolonged trial. "It is, however, an unpardonable mistake that such experiments should be made without the co-operation of the makers of incandescent lamps." At least so says the *Elektrotechnische Zeitschrift*; but if a quarter of what is said about German lamps is true, that can be understood without assuming anything worse than a fear that good makes may get confounded with the general run of bad ones.

Velocity of Electric Waves.—Mr. Clarence A. Saunders's researches on the velocity of electric waves are published in the *Physical Review.* A novelty in his method is to check the velocity of the rotating mirror by a motor accurately regulated by a synchronous alternating motor on the same axle instead of the old method of a tuning-fork. Mr. Saunders's average values are 29,820 and 29,970 × 10^6 cm./sec., the larger number resulting from using a longer circuit. If the wires were perfect conductors, the velocity of propagation should be the same as that of a wave in the dielectric—*i.e.*, to the velocity of light—and theory indicates that in the present case the error due to the resistance of the copper wires would be too small to be taken into account.

Pacific Cable Conference.—The Canadian Government has asked that the reassembling of the Pacific Cable Conference may be postponed until the second week in December. The Canadian delegates will be Sir Donald Smith and Mr. Sandford Fleming, the latter having been nominated the second Canadian commissioner in place of Sir Mackenzie Bowell, who has retired. Neither Mr. Laurier, the Premier, nor Sir Richard Cartwright, the Minister of Trade and Commerce, is now expected to visit England this year, but they may come to London after the next session. A later telegram states that Canada will appoint three representatives, as by this means the desire of Queensland to nominate a third delegate from Australasia will be met.

The Remuneration of Instructors.—The Egyptian Government in its *Journal Officiel* gives notice that there are a number of vacancies for teachers of English, of mathematics, and of art and drawing in the Government schools. It is sometimes complained that technical teaching is inadequately remunerated in England, and, therefore, to save the Egyptian Government from a rush of foreign candidates, it may be as well to add that the time of application for these posts expired on the day the *Journal Officiel* reached our shores. Also that the maximum salary asked must be something less than £72 per annum, and, in addition, £3 has to be paid to the Revenue Department of the Egyptian Government for the privilege of making application for one of these vacant posts.

Carborundum.—Silicon carbide, for use as a grinding material, is a crystalline substance, and must therefore have presumably undergone fusion. It is not impossible that a substance of similar composition though not crystallised may be formed at a temperature lower than that necessary to melt it and cause it to crystallise. As the product of an electric furnace is always highly heterogeneous, it is reasonable to suppose that amorphous SiC, unfitted for abrading purposes, may be found there, and the *Zeitschrift für Electrochemie* suggests that it might prove a profitable by-product as a carburetting and siliciding agent. Carbides, silicides, nitrides and borides of manganese, magnesium, and aluminium are suggested as possible products for the common profit of the steel-maker and the electro-metallurgist.

Electric Lighting at the Law Courts.—There have been some considerable alterations in the electric lighting arrangements at the Law Courts during the Long Vacation, and, if report is to be trusted, everything necessary was done to make the new arrangement a shining success—except to switch the light on. As the tale goes, on entering the building their lordships (the Queen's Justices) were ceremoniously conducted to a lightless robing-room, there to form themselves into the order of precedence in which they were to proceed through the Grand Hall. The next thing was a voice speaking in the telephone, "Turn on the electric light in the robing-room instantly!" If the tale is untrue, it is not we but the London correspondent of the *East Anglian Daily Times* on whom rests the responsibility.

Tramways and Telephones.—The report of Mr. P. van Vloten, of Brussels, on the subject of the disturbances produced in telephones by the working of electric tramlines is published in the *Bulletin* of Belgian Société d'Electriciens. The report was made to the International Tramways Union at its meeting at Stockholm this year. The report recommends the use of a large number of sections in the commutators of the motors and care to secure good rail and trolley contacts, and as little vibration as possible. It is, however, held that the telephone also should do what is possible to protect itself. "A telephonic system with earth return is incomplete and defective." Much attention is devoted to English

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practice, and in reference to the danger of electrolysis the prescription of the Board of Trade limiting the potential drop for an uninsulated return to seven volts is looked upon as unnecessarily severe for long lines.

The Clydebank Cell.—A Glasgow contemporary says: "About two years ago a stir was caused in engineering circles [presumably local circles] by an announcement that two Clydebank young men named Macdonald had made a discovery which would revolutionise the application of electricity for motive purposes. The features of their invention were said to be the smallness and lightness of the battery and the simplicity of the ingredients—salt water and coal ashes. Experts were sceptical [naturally, it is a way they have], but it is stated that a syndicate has now been formed with the object of testing the value of and exploiting the invention. It is said that the vessel 'Medusa,' which was employed by Dr. John Murray, of the Challenger Expedition, for marine investigations, has been purchased for experimental purposes." The last paragraph fairly beats us. A cell of that size would be unexampled even in the annals of primary batteries.

Manchester Association of Engineers.—At a meeting of the members of this association last Saturday, Mr. G. T. Pardoe read a paper on "Water Power and its Development." He thought water power might be used effectively for electric lighting purposes in a number of small towns in the North of England and in Wales. The inhabitants of those towns, however, did not appear inclined, or did not have sufficient money, to embark on what was for them a new enterprise, and outside capital was necessary for the working of that field. People seemed to think they could have water power for nothing. Apparently they forgot that the much-maligned capitalist required a return for his money, and that the works needed repairs and renewals. Whether power of that kind could be rendered available at a lower cost than power derived from coal was a question only to be solved after close consideration of each individual case.

Obituary.—Mr. James Henry Greathead, the engineer, died at his residence, Streatham, last week. He was a member of the council of the Institution of Civil Engineers, and had carried out many extensive engineering works; but he will be chiefly remembered as the pioneer in that system of tunnelling which bears his name, has revolutionised the method of tunnelling hitherto adopted in large cities, and has practically solved the problem of rapid transit in London. The City and South London Railway was one of the first to be constructed by Mr. Greathead, the Central London and the Waterloo and City Railways are in course of construction, and others are authorised. These tunnels would not have been practicable had it not been for the device known as the Greathead shield, which enables tunnels to be driven with safety and economy underneath buildings of all kinds without disturbance, and under rivers without danger to the workmen.—The death is announced of Mr. William Allen, head of the firm of Bessemer and Sons, at Sheffield at the age of 72.

A French Opinion.—The *Revue Industrielle* in its "Chronique" refers to the report of the British Consul at Naples made some time ago, in which the absurdity of English manufacturers forwarding to Italy for circulation catalogues printed in English, and with all quantities in English weights and measures, was strongly insisted on. Our Paris contemporary says plainly that even when a textual translation of the catalogue is made the addition of figures in English weights and measures does more harm than good in countries that use metres, kilogrammes, and litres or their equivalents under native names. In conclusion, it is urged that the remarks of our consul are worth consideration, not only in England, but in France, and in particular by French "consuls, who are rarely as ready as the English consul at Naples to exert themselves to push the introduction of the products of their country's trade and industry." It is believed that the Naples consul's report was not pleasing to everybody in this country. Apparently the French wish they had some like him.

Boiler Incrustation.—In a communication originally appearing in the *Oesterreiche Zeitschrift für Berg- und Hüttenwesen*, Rubricius, an Austrian chemist, recommends yet another anti-incrustation compound for boilers, which is stated to have furnished remarkably good results during the year that it has been in use at Anina and other localities in Austria-Hungary. To the feed-water there is added a mixture consisting of 90 per cent. of soluble chromates and 10 per cent. of soda. These salts transform the more or less soluble carbonates contained by the water into soluble chromates, which settle in the shape of slime without adhering to the walls of the boiler, and the latter can easily be cleaned by washing. The beneficial effect of the process will be felt even in the case of boilers which are already lined with thick layers of incrustation, for these will be gradually reduced and transformed into slime. On an average, $\frac{1}{10}$oz. of the mixture should be added to 35 cubic feet of water. For an ordinary boiler 3oz. to 4oz. per day would be sufficient. Where water with very high lime contents is being used, the dose should be increased a little; the exact quantity needed can be determined by a preliminary test.

Crystal Palace.—We have received from the manager the prospectus of the Victorian Loan Exhibition, which it is intended to open on May 24, the anniversary of her Majesty's birthday, and which will illustrate, by historical and modern specimens, original models and practical examples—(1) the famous inventions in the arts and industries of the last 60 years; (2) the naval and military services, 1837-1897; (3) the fine arts of the Queen's reign; (4) the national sports, pastimes, and recreations of the Victorian era; (5) the colonies and dependencies. As to Section 1 ("famous inventions"), it is stated that "the available space for this section of the exhibition being limited, the exhibits will be restricted to those inventions that have been most conducive to the development of the commerce, wealth, and prosperity of the nation, those, for instance, connected with electricity and telegraphy, heating and lighting, hygiene, labour-saving machinery, locomotion, photography and its applications, printing machinery, textile industries, utilisation of natural forces, utilisation of waste products, etc." We have also received the programme of the Wednesday winter lectures and next year's Handel festival.

Electric Locomotive in New York.—Reference has before been made to a trial to be made of an electric locomotive on the Manhattan elevated railroad in New York. The trial took place on October 5, the experiment being made on the Thirty-Fourth-street branch between the Long Island Ferry and Third-avenue. A third rail laid on the outside of, and 10in. higher than, the regular rails carries the current. Contact is made by means of two sliding steel shoes. The motorcar carries, when fully equipped, a storage battery of 256 cells, which may be used in case of emergency, and which serves to keep the load on the line and on the station fairly uniform. The battery alone, it is said, will operate a train for 19 miles at a speed of 35 miles per hour. The motorcar is 18ft. long, and slopes from a height of 8ft. in the centre to 3ft. at the ends. The electric current is also used to light the cars. The loco-

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motive has two motors of 125 h.p., and weighs 10 tons. An overhead railway of the New York type is the sort of thing that would not be looked upon with favour in this country. But if electric locomotives get used upon it, it will remove one source of anxiety to ordinary people in the street—namely, there will be no possibility of bits of coal or ashes, cold or hot, coming down on their heads.

A New Use for Steam-Rellers.—The following from a weekly contemporary, contains a most amusing amount of misinformation. The initial difficulty of finding Mauritius in the West Indies is unfortunately slurred over. "A new use for a steam-roller has been found. The Governor of Her Majesty's Crown Colony of Mauritius recently purchased one and had it shipped out to the West Indies for macadamising the roads. When it arrived, unforeseen difficulties in the way of making roads with it arose, and as its cost had been something like £500, it looked as though the colony would be considerably out of pocket by the transaction. The authorities, however, determined that it was a pity to waste it, so they fixed it up with wooden sprockets till the wheels and rollers could revolve clear off the ground, and then they geared it on to an electric dynamo. In this capacity it works splendidly; the roller acts as a heavy flywheel, and with the motive power thus supplied the electric light works better than it ever did before." Other "interesting items about the Mauritius" are added, but they relate to bicycles, golf, cricket, dominoes, and such frivolous matters, and they are doubtless equally authentic. Yet the colonies complain that the mother country knows little about them and cares less.

Engineering Societies.—The Institution of Civil Engineers meets on Tuesday, November 3, at 8 p.m., for the opening of the seventy-eighth session, when Mr. J. Wolfe Barry, C.B., F.R.S., will deliver an inaugural address on taking the chair as president.—The Institution of Mechanical Engineers meets Wednesday, November 4, and Thursday, November 5, at 7.30 p.m. The papers to be read and discussed are: "Research Committee on the Value of the Steam Jacket; Experiment on a Locomotive Engine," by Prof. T. Hudson Beare, F.R.S.E,, and Mr. Bryan Donkin (Wednesday); "Transmission of Heat from Surface Condensation through Metal Cylinders," by Lieut.-Colonel English and Mr. Bryan Donkin (Wednesday); "Break-downs of Stationary Steam-Engines," by Mr. Michael Longridge, of Manchester (Thursday).—The Institution of Junior Engineers has its inaugural meeting on Friday, November 6, at the Westminster Palace Hotel. The presidential address will be delivered by Mr. A. R. Binnie, M.I.C.E., and the chair to be taken at 8 p.m. by the retiring president, Mr. A. Denny, M.I.N.A.—The Society of Engineers meet on Monday, November 2, for Mr. D. B. Butler's paper on "The Effect of Admixtures of Kentish Ragstone, etc., upon Portland Cement." The meeting is at the Royal United Service Institution, Whitehall, at 7.30.

Technical Education.—In an address to students delivered in connection with the opening of the session of the Department of Science, Technology, and Arts of the Yorkshire College, Leeds, Mr. Asquith said from the gigantic sum raised by taxation in this country the comparatively moderate pittance which university colleges demanded might well, he thought, be sanctioned by the Chancellor of the Exchequer, and it would not be the least usefully expended of the money that passed through his hands. However, he advised them not to rely upon Governments alone. Mr. Asquith also remarked that the grammar schools which exist all over the country had been awakened to new life. If it means to the proper treatment of science teaching the writer had not yet observed it. Mr. Chamberlain at Birmingham has a plea for debating societies. "I am afraid that the true meaning is too often lost in the jangle of the bell; therefore there is the more reason in these days of technical education that there should be, among other things, a school of debate, where young men may be taught to concentrate their thoughts and express them in appropriate and in forcible language." But does a school of rhetoric do this? The advice of the Duchess was: "Take care of the sense and the sounds will take care of themselves." Mr. Roberts Beaumont has also written to the *Times*, but says little new.

Electric Light and Plant Growth.—Some particulars of recent experiments in the application of electricity to farming and horticulture have been given in the *North American Review*. At Cornell University it has been found that plants receiving the bright electric rays at night and the sunshine in the daytime were found to grow much faster than those not thus supplied with the artificial stimulant (similar results are produced by the almost continuous daylight of the sub-Arctic regions). Lettuces, spinach, radishes, and similar vegetables were brought to maturity in almost half the time ordinarily required. The effect upon flowering plants was almost as startling. The plants were made to shoot up rapidly, and under forced stimulation the stalks grew up tall, slender, and weak. The blooms were hastened in their growth, and in the case of the petunias they produced more flowers than by the old system. Verbenas, on the other hand, were uniformly injured when placed near the electric lamp. Both the leaves and the flowers were hastened in their growth, but they were small and insignificant, while many of the lower clusters died before they had reached their full expansion. The effect of the electric light upon colours was even more interesting than upon the growth of the plants. The colours of the tulips were deepened and made more brilliant, while most of the scarlet, dark red, blue, and pink flowers were turned to a greyish white; but nearly all of the flowers artificially stimulated into beauty by the electric light soon lost their brilliancy and faded much more quickly than those raised by Nature's methods.

The Light Railways Act.—We have received from Messrs. Reeves and Turner, 100, Chancery-lane, "The Light Railways Act, 1896." This is a book compiled by Mr. Evans Austin, M.A., LL.D., of the Middle Temple (barrister-at-law), treating, as its title denotes, with the Light Railways Act, 1896 (59 and 60 Vict., c. 48). The aim of the author is to give, as far as possible, all the information likely to be required by local authorities and others, and therefore he has appended sections of the various Acts relating to the subject, such as the Lands Clauses Consolidation Act, 1845; the Board of Trade Arbitrations Act, 1874; the Arbitration Act, 1889; a list of the enactments relating to safety, etc.; a table of the principal general enactments relating to railways; and the rules made by the Board of Trade with respect to applications to the Light Railway Commissioners for orders authorising light railways. The book is, of course, practically a reprint of the whole and portions of Acts of Parliament, but the usefulness of it lies in the fact that the whole of the laws which have any direct influence on the question of light railways have been selected with great care and put together in one volume. The author, in his preface, calls attention to the fact that no definition of a light railway is attempted by the Act It leaves to the Commissioners a very wide discretion in this respect. Indeed, no definition is possible, the circumstances in every part of the country being so various that do definition would suit them at all. A clear and concise general summary of the Act at the beginning of the

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book and a copious index at the end considerably add to its value.

Antitoxins and Electrolysis.—Some time ago reference was made to the experiments conducted in France on the effect of alternating currents of high frequency on bacteria and bacterial toxines. Physiologists do not always keep their physics up to date, and therefore it is less surprising than would seem at first sight that in some quarters it should have been imagined that "antitoxin" was in some way manufactured by the alternating current. On the very good authority of an article in the *Lancet*, it appears, however, to have been the case. It would, however, seem to be indicated by the investigation of Mr. Marmier, that the action of the high-frequency current on bacteria differs little in principle from that of a continuous one. Mr. Marmier, in a contribution to the *Annales de l'Institut Pasteur*, gives a series of experiments made with continuous currents similar to those carried on by Smirnow and Krüger and with currents alternating at high frequency such as were used by D'Arsonval and Charrin. He finds that with venin and with diphtheritic toxins he is able to obtain no attenuating effect with alternating currents of high frequency, but that with continuous currents there is a distinct attenuation of the virus to be noted. He finds, moreover, that continuous or alternating currents of low frequency destroy bacterial toxins simply because they have the power of producing hypochlorites and chlorine from the chloride of sodium dissolved in the solution of toxins, this substance in a nascent condition exerting a considerable effect upon the toxins. He considers, in fact, that the Hermite process is the one that is brought into play in the attenuation of the toxins that are in the fluid. In fact, the fluid after electrolysis is perfectly different as regards its antiseptic power from the fluid before electrolysis is commenced.

Motorcart Regulations.—The draft regulations proposed to be issued by the Local Government Board under the powers conferred on them by the Locomotives on Highways Act, 1896, were considered at a meeting held at the London Chamber of Commerce on Monday last, with Major Flood Page in the chair. It was considered best that the proceedings should be considered private, since the meeting was practically an answer to an invitation of the Board to make suggestions to it for consideration. It is, however, no secret that the Board is doing its honest best to produce a set of rules which, while providing for the public safety and the public fear of anything novel, will leave the new industry free to take its natural course of development. If that were not so, it would hardly have been possible for the proceedings to have been over well within the hour at a meeting at which, not only the societies, but the interests of electricity, oil, and steam motors, as well as engineering in general, were represented. In fact, very few suggestions were made, and if there is no adverse influence from other quarters, and the rules go through in anything like their present form, they will be found to be as satisfactory both to the general public and the manufacturers as is possible under the circumstances. Of course the whole difficulty lies in providing a set of regulations which shall be short and comprehensible and yet shall cover the necessities of everything from a light traction engine down to an automatic cycle. Then, again, independent of size, there is a cross division as to motive power. Take, for instance, a regulation that a motor vehicle must not be left unattended. A light electric tricycle or car, with its wheels braked and its switch locked, would be about as dangerous as a crate of the same size. It is, in fact, absolutely safe. On the other hand a steamcar, perhaps burning petroleum, if not absolutely unsafe, is at least one of those things of which it cannot be said for certain that there is no possibility of mischief if it happens to be left too long—that is to say, if the owner does not want to find himself without steam when he comes back to it. The difficulty is not lessened by the fact that the type of vehicle to be legislated for is at present certainly untried, probably unconstructed, and indeed possibly as yet uninvented. But so long as a considerable section of the public takes *omne ignotum pro terrifico* it would be eminently undesirable to have no special rules. Moreover, whatever form they take, the Board's regulations will not have the rigid character of an Act of Parliament. They can be changed, and even if they could not such a very uncertain piece of mechanism as the horse and cart manages to get along all right within the unalterable provisions of the Highways Act.

The Heilmann Locomotive.—The *Iron and Coal Trades Review* is responsible for the statement that "Railway engineers, both in Europe and in the United States, have of late been greatly exercised over the prospect of finding the electric locomotive superseding the ordinary steam locomotive engine which has played so important a part in transportation during the last 60 years," and adds that "up to the present time the interest of the electrical world has chiefly been centred in the Heilmann locomotive, which has been constructed in France, and operated on two of the most important railway lines in that country. M. Heilmann is a manufacturer of electrical plant and a locomotive builder, who carries on extensive works at Havre and who is well known in Paris as an original and enterprising engineer. His locomotive, which was originally looked upon as something of a curiosity, has forced its way into such prominent notice that negotiations are said to have been concluded for building several others on the same lines, but of 2,000 h.p. for Russian railways, and a company which has been formed in Russia proposes to pay, if it has not already paid, £500,000 for the patent rights for that country." So far as it is known to the writer, the opinion both of the electrical and engineering world has been that the use of dynamos and motors as a kind of speed gear between the steam-engine and the driving wheels—for that is what the Heilmann engine comes to—does not hold out a very hopeful prospect. The double conversion of energy into current and back again is not altogether a proceeding that makes for economy, and the platform and tender of a locomotive is rather a cramped domain into which to pack the mechanism of a power-transmission line. Moreover, the ship-shape end, presumably adopted as a precaution against wind pressure at high speeds, is taken as an indication that the inventor has not really grasped the relative importance of the various factors which limit the rate of speed of a locomotive, or, for the matter of that, the proper way of treating them. Outside the shops at Rugby and Thames Ditton most of the information as to the Heilmann locomotive current in this country has been obtained from the proceedings of the Société des Ingenieurs Civils, at Paris. The Société has discussed the subject pretty fully from time to time, and, as these columns have testified, the Heilmann locomotive has come in for some pretty sharp criticism there. It is now suggested that the Willans type of engine will not do—in fact, that the reciprocating type of engine must be abandoned altogether and steam-turbines adopted. Now, the steam-turbine is a very pretty thing, and valuable enough where space is small and speed is great. But no one has yet accused it of economy, and, after all, that is the point; for it is not a question of doing a thing, but of doing it better than other engines.

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THE PRINCIPLES OF ALTERNATE-CURRENT WORKING.*

BY ALFRED HAY, B.Sc.(EDIN.), A.I.E.E.

(Continued from page 456.)

89. We are now in a position to study the behaviour of a condenser when placed on an alternating-current circuit. We shall first of all consider the simple case in which the circuit is made up of a condenser whose terminals are connected to a source of alternating E.M.F., and we shall suppose the resistance and inductance of this source to be negligible. We shall also assume that the impressed E.M.F. varies according to the simple harmonic law. From the first assumption it follows that the P.D. at the terminals of the condenser is at every instant equal to the impressed E.M.F.

Let e stand for the instantaneous value of the E.M.F., q for the instantaneous quantity, and C for the capacity of the condenser. Then we have the relation (Art. 85)

$$q = C e,$$

and since we suppose e to vary according to the simple harmonic law, it follows that q will vary according to the same law, and be in phase with e.

Let E stand for the maximum value of e, and Q for the maximum value of q. Then $Q = C E$. The E.M.F. may be represented by an alternating vector (Art. 15) derived from the rotating vector O A (Fig. 63), of length E. The quantity of electricity in the condenser may be represented by another alternating vector, which is in phase with the first, but whose maximum value is C E. Next, since the current is measured by the rate of change of the quantity

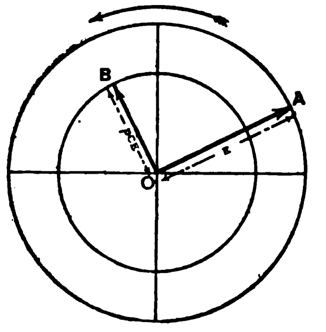

FIG. 63.

(Art. 87), and since the latter is represented by an alternating vector, it follows that the current itself will also be represented by an alternating vector, of amplitude $p C E$ (Art. 22), this vector being $\frac{\pi}{2}$ in advance of the quantity vector as regards phase. The letter p stands, as usual, for 2π times the periodicity.

If, therefore, in Fig. 63 we draw $O B = p C E$ at right angles to O A, and if we suppose the whole diagram to revolve round O with constant angular velocity p, then the projections of the rotating vectors O A and O B on the vertical axis will give us the instantaneous values of the E.M.F. and current respectively. We thus arrive at the following important result:

If a simple harmonic P.D. of amplitude E be applied to a condenser of capacity C, then the current through the condenser will be of amplitude p C E, and will be $\frac{\pi}{2}$—i.e., a quarter-period—in advance of the P.D. as regards phase.

90. It may be well, perhaps, at this point to anticipate a paradox which might possibly occur to the student and cause some difficulty. According to the result just established the current has its maximum value when the E.M.F. passes through the zero value. Let us suppose that there is a switch in the circuit and that the switch is closed at the instant of zero value of the E.M.F. Now, since the E.M.F. is just passing through its zero value it does not matter whether, at the instant considered, the switch is closed or not. From this it would appear to follow that there is a current through the condenser before the closing of the switch. What really happens is this. When the switch is closed the current starts from a zero value, but the first few waves are of an abnormal type; the current gradually gains on the E.M.F. as regards phase, and ultimately reaches a phase difference of $\frac{\pi}{2}$. Our investigations are concerned with the steady periodic state, and not with the abnormal waves which make their appearance on first closing the circuit.

A similar difficulty occurs in the case of an inductive circuit, and is similarly met.

91. The result established for a simple harmonic E.M.F. wave may, by the principles of Arts. 43-45, be extended to waves of any shape whatever. The method is the same as that used in working out the numerical example of Art. 46. We shall take the same E.M.F. as that used in Art. 46—viz.:

$$e = 2{,}000 \sin p\,t - 600 \sin 3\,p\,t,$$

and, assuming a periodicity of 100 ∿ per second, suppose that this E.M.F. is applied to a condenser of capacity $= 15{\cdot}9$ microfarads. We then have

$$p = 2\,\pi\,n = 200\,\pi\,;\ 3\,p = 600\,\pi.$$

$$p\,C = 200\,\pi \times 15{\cdot}9 \times 10^{-6} = {\cdot}01 \text{ approximately,}$$

and $$3\,p\,C = {\cdot}03.$$

Hence, taking the first term in the expression for the

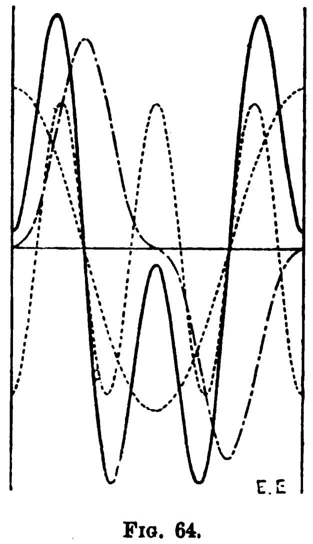

FIG. 64.

E.M.F.—*i.e.*, 2,000 $\sin p\,t$—we find that the corresponding current is represented by $20 \sin\left(p\,t + \frac{\pi}{2}\right)$; while the current corresponding to the second term, $-600 \sin 3\,p\,t$, is given by $-18 \sin\left(3\,p\,t + \frac{\pi}{2}\right)$. The total current through the condenser is therefore represented by

$$20 \sin\left(p\,t + \frac{\pi}{2}\right) - 18 \sin\left(3\,p\,t + \frac{\pi}{2}\right).$$

In Fig. 64 the chain-dotted curve is the E.M.F. curve (the harmonic components of which are shown in Fig. 37). The full-line curve is the current curve, whose harmonic components are shown dotted. The student will at once observe that the current curve departs much more widely from the simple sine form than does the E.M.F. curve; so that the effect of a condenser on the current curve is to produce still greater distortion than that which is already present in the E.M.F. curve. In this respect the effect of a condenser is the reverse of that produced by an inductance, as the student will readily see by referring to Art. 46. An inductance may be said to have a smoothing effect on the current wave, and a capacity a distorting effect. The reason for this is not far to seek. In the case of an inductance, the current, for a harmonic E.M.F. of

* Based on a series of evening lectures delivered at the University College, Liverpool.

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given amplitude, varies inversely as the periodicity $\left(I = \frac{E}{Lp}\right)$; but in the case of a capacity, it varies directly as the periodicity ($I = pCE$). Hence an inductance will tend to suppress the higher harmonics in the current wave, whereas a capacity will tend to bring them into greater prominence.

92. Returning to the case of a simple harmonic E.M.F., we see that, by the result established in Art. 88, the relation between the P.D. at the terminals of a condenser and the current through it is given by the equation

$$I = pCE \quad . \quad . \quad . \quad . \quad . \quad . \quad (25)$$

where I and E may stand for either the maxima or the R.M.S. values of the current and P.D. respectively. It will be instructive to compare and contrast the behaviour

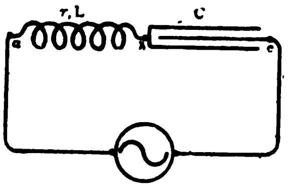

FIG. 65.

of a simple inductance with that of a simple capacity when the impressed E.M.F. follows the simple harmonic law. This is done in the following table:

Simple inductance.	*Simple capacity.*
The current is $\frac{\pi}{2}$ *behind* the E.M.F. as regards phase.	The current is $\frac{\pi}{2}$ *in advance* of the E.M.F. as regards phase.
The current varies *inversely* as the product of the inductance and periodicity.	The current varies *directly* as the product of the capacity and periodicity.

Since the effects produced by an inductance are thus seen to be the very reverse of those produced by a capacity, the idea at once suggests itself that a capacity may be used to neutralise the effects of an inductance. As we shall see presently, this may be accomplished when the E.M.F. obeys the simple harmonic law.

93. Let us suppose that a circuit consists of an inductive resistance connected in series with a condenser, as shown in Fig. 65. Let r and L be the resistance and inductance of the circuit respectively and C the capacity of the condenser. Let us suppose that the current obeys the simple harmonic law, and that its amplitude is I. The problem is to find the impressed E.M.F. We may regard the latter as made up of three components: (1) the $r\,i$ component; (2) the $L\,i'$ component (Art. 37); (3) the P.D. at the condenser terminals.

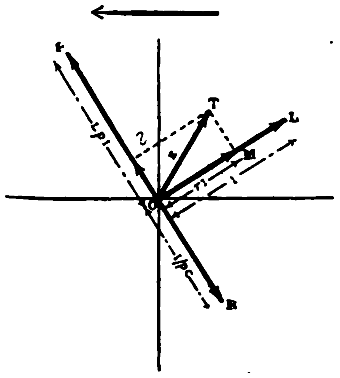

FIG. 66.

In Fig. 66, O L is a rotating vector of length I. The alternating vector derived from this by projecting it on the vertical axis gives the current. O M is a rotating vector of length r I, and coincident in direction with O L; the projection of this vector at any instant on the vertical axis gives the $r\,i$ component of the E.M.F. at that instant. The $L\,i'$ component is represented by the projection on the vertical axis of a rotating vector O P, of length LpI drawn at right angles to O L (Art. 37). Lastly, the condenser P.D., which by the results established in Art. 89 is $\frac{\pi}{2}$ behind the current as regards phase, is represented by the projection of a rotating vector O R, of length I/Cp, drawn at right angles to O L, but in a direction opposite to that of O P.

The whole diagram is, of course, supposed to revolve in a counter-clockwise direction (as shown by the arrow) round O, the angular velocity being p (where $p = 2\pi n$).

The instantaneous impressed E.M.F. is the sum of the projections of the rotating vectors O M, O P, and O R on the vertical axis. But this sum is (Art. 12) the same as the projection of the resultant of the three rotating vectors. In order to find this resultant, we may first of all find the resultant of O P and O R. If we assume that O P > O R, then the resultant of these two vectors will be represented by a vector O S, of length $LpI - I/Cp$, and having the same direction as O P. By compounding the vectors O S and O M (Art. 11), we find the required resultant O T of the three vectors.

We thus see that the impressed E.M.F. is represented by the projection on the vertical axis of the rotating vector O T, and from the geometry of the figure we can at once determine the maximum value of the impressed E.M.F. and the angle of phase difference T O L between it and the current. Noticing that $OM = rI$, and $MT = OS = \left(Lp - \frac{1}{Cp}\right)I$, we get

$$OT = \sqrt{OM^2 + MT^2}$$
$$I = \sqrt{r^2 + \left(Lp - \frac{1}{Cp}\right)^2}.$$

Hence, denoting by E the maximum value of the impressed E.M.F., we see that

$$I = \frac{E}{\sqrt{r^2 + \left(Lp - \frac{1}{Cp}\right)^2}} \quad . \quad . \quad . \quad (26)$$

Again, if θ stand for the angle of lag T O L of the current behind the impressed E.M.F., we have

$$\tan\theta = \frac{MT}{OM} = \frac{Lp - \frac{1}{Cp}}{r} \quad . \quad . \quad . \quad . \quad (27)$$

94. Several important results follow at once from the relations just established. If $Lp = \frac{1}{Cp}$, then we get $I = \frac{E}{r}$, and $\theta = 0$. In other words, by choosing the capacity so that it is equal to $\frac{1}{Lp^2}$, we cause the current to come into phase with the impressed E.M.F., and to assume a value which is simply equal to the quotient of the E.M.F. by the resistance of the circuit. The effect of the inductance is thus completely annulled by the capacity.

Again, a glance at Fig. 66 shows that the current may lag, be in phase with the E.M.F., or lead, according as Lp is greater than, equal to, or less than $\frac{1}{Cp}$.

Further, we have the important result that under certain conditions *the P.D. at the condenser terminals may considerably exceed the impressed E.M.F.* in the circuit, so that a voltmeter connected across the points b and c (Fig. 65) will give a higher reading than one connected across a and c. This is evident from the fact that for certain values of the resistance, inductance, and capacity the vector O R may exceed O T.

Similarly, *it may happen that the P.D. across the inductive resistance exceeds the impressed E.M.F.* For the vector O P may under certain conditions exceed O T. If this is the case, a voltmeter connected across $a\,b$ will give a higher reading than one connected across $a\,c$ (Fig. 65).

(To be continued.)

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RAILWAY BLOCK SIGNALLING.

BY J. PIGG.

(Continued from page 457.)

Single-Line Working.

The principles under which single-line block working is carried on differ in no way from those adopted for ordinary double-line work, the section limit being imposed upon trains passing between any two adjoining cabins. Inasmuch, however, as trains passing in either direction have necessarily to pass over the same line of rails, it is obvious that some other precaution than that afforded by the ordinary form of block is necessary to ensure that two trains shall not, through negligence in any way, enter the section from opposite ends at the same time. This is generally accomplished by the "staff," or "staff and ticket," system of working single lines, to which block working is often merely supplementary.

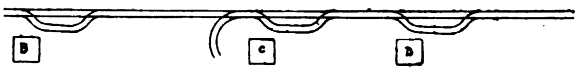

Fig. 83.—Staff Sections, B—C, C—D.

In single-line working the line is divided into a convenient number of parts, at the junctions between which passing places are provided for trains proceeding in opposite directions; and the driver of any train passing through any such section, as B C (Fig. 83), must obtain from the signalman at the entrance to the section some visible authority other than, and supplementary to, that given by the usual mechanical outdoor signals, and must deliver the same to the signalman at the exit end on his arrival there. In the case of the simpler single lines this authority to proceed is given by the signalman handing the train staff (Fig. 84) to the driver of the train about to enter the section. As there is only one staff to each section, and as no train may enter a section without the staff accompanying it, the driver, on receiving the staff, knows that no train will be sent from the opposite end, and he may therefore proceed as far as the next staff station. It will be noticed that the signalman at intermediate staff stations will have two staffs to deal with, whilst the signalmen at the ends of the single line will have only one to handle. In order to prevent interchange of staffs, each is in some way made distinct from the others, either by difference in form or colour, or by being appropriately lettered

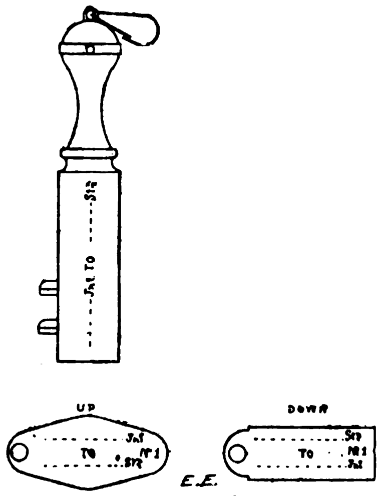

Fig. 84.—Staff and Tickets.

Trains on single lines worked by "staff" alone are liable to considerable delay, more especially where the line is fed with traffic at one or more points, such as at C (Fig. 83). If a train is sent from "B" to "C," say, and takes the staff, no train can pass between these points in the same direction until the staff has been returned to "B." This may be done by a train passing from "C" to "B" in the ordinary course, or a special engine may be sent with the staff to B; or, in the event of an engine not being available, the staff may be sent by a messenger on foot, or horseback, if the circumstances are sufficiently urgent. In any case, considerable delay to traffic results from any deviation from the ordinary or prearranged working of the line, and special traffic must be carefully arranged to fit in with the ordinary, and special advice of additional trains must be given to the officials concerned in the working of the line, or that portion affected.

In order that trains may pass over any staff section in the same direction in succession, the modification known as the "staff and ticket" is introduced, the "ticket" being a supplementary authority for the driver to proceed, which is understood to be available for use *only* when the staff for the section to be entered is in the possession of the signalman at the *entrance* to the section.

The staff usually takes the form of a cylinder of brass or hard wood of distinctive shape, and has engraved upon its surface the names of the points constituting the staff section for which it is available. The "ticket" is usually a flat iron plate of oval or rectangular form (Fig. 84), and is similarly lettered. In addition, the very necessary information respecting the direction in which it is to be used—*i.e.*, for "up" or "down" journeys—and its number are marked upon it. By these means the "ticket" affords a check upon the signalman, and ensures the use of the proper ticket, and also affords information to the driver, by its number, of the condition of the line through which he is to proceed. Each cabin is provided with a small lock-up box, in which a certain number of "tickets" are kept for use as required. The key for this box forms part of the staff, and the ticket-box, therefore, can only be opened by the signalman who has possession of the staff. If a train is to be sent away from the staff station, and it is certain that another will require to follow it before the staff could be returned under ordinary working conditions, a "ticket" is given to the driver, and the staff is retained by the signalman until such time as it becomes necessary for the staff to be sent to be available for trains in the opposite direction, tickets, in their proper numerical order, being delivered to drivers of all successive trains except the last, to whom the staff is given. This method constitutes a great advance on simple staff working and enables traffic to be handled with much greater facility. Even with this modification, however, the schedule of arrangements of trains must be closely adhered to, and if any deviation from it is made, or trains are sent unexpectedly, it is a mere matter of chance if delay does not ensue.

Fig. 83 shows a single line divided into staff stations with passing places for trains proceeding in opposite directions. The number of staff sections for any line will depend upon its length, the amount of traffic passing over it, and the number of points at which traffic is lifted or delivered. For busy lines it is, of course, of advantage for the staff sections to be short, in order to lessen the delay to trains waiting for others to clear the section. On the other hand, cutting the line into numerous staff sections involves expense in providing passing places, staff cabins, and signalmen; and delays to through traffic in consequence of the frequent slackening of speed to exchange staffs or "tickets."

Where the "staff and ticket" system is in use, and trains proceeding in the same direction may follow each other, a combination of the block system with the staff is found to be advantageous. In Fig. 85 a portion of the staff section, B-C, is shown as split into three block sections,

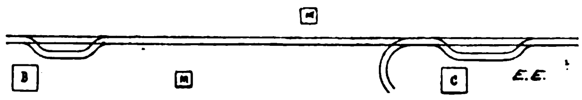

Fig 85.—Staff Section B—C, with Intermediate Block Sections, B—M, M—M', M'—C.

B-M, M M¹, and M¹ C. Block apparatus of any suitable kind is provided in B, M, M¹, and C, and the usual complement of mechanical signals is provided at each place. A train leaving B, say, with a ticket for C would be signalled on the block instrument in the usual way, and would be cleared back to B when it passed M and was proceeding to M¹. A second train might then be sent away from B in the same direction either with a second ticket, or the staff, as might be desirable. Between B and C the trains are worked under block rules only, and they are not required to stop or slow down for

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the exchange of staffs at M or M[1], but may run straight through so long as the proper mechanical signals are exhibited. At the same time there is nothing to prevent the ordinary work of lifting or leaving traffic being performed at either M or M[1]. In this way, as will be evident, a glut of traffic passing in one direction can be much more readily dealt with than by the simple staff or staff and ticket systems alone. Although the fact that between B and C there may be three trains would seem a violation of the principle underlying the staff system, yet on closer examination it will be evident that the primary object of the staff is to prevent trains entering a section from opposite ends at or about the same time, and the trains in the case considered are all passing in the same direction. Further examination will show that the staff section space has been replaced by a shorter block section space, and so long as no irregularities occur the system is perfectly safe.

There is nothing special in the instruments used for single-line block working where nothing more than the mere indication of the condition of the line is required. Any form of instrument in use on double lines may be easily adapted to single lines. The single-needle instruments described in connection with double-line working only require to be provided with a pin at each end for pegging the needle, instead of at one end only, there being, of course, only one indicator

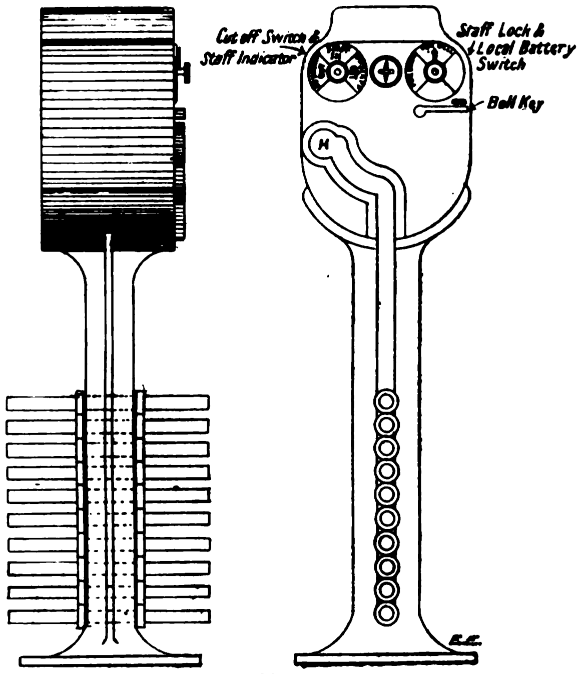

FIG. 86.—Webb and Thompson's Electrical Train Staff Instrument.

for each section and only two wires required. Winter's block instrument (Fig. 51) simply requires Z of the line battery to be connected to the terminal, S *p*, to enable it to be used for single lines. In this case one instrument serves for the two sections which are controlled from the cabin. Block instruments in the design of which some attempt has been made to secure a degree of automatic control have some claim to be considered as capable of being used on single lines without the aid of the staff system, but such adaptations have made no progress in this country. Other instruments, such as Walker's, Harper's, Fletcher's, and the single-needle instruments can only be used to facilitate traffic over the lines, and are subordinate to the staff as a *safety* appliance.

The want of flexibility in the staff system, and the delay consequent upon any deviation from the ordinary or prearranged working, has led to modifications, and instruments have been devised by means of which safety is ensured and much of the delay to the traffic is obviated. The principal alteration consists in the abolition of the single staff governing the passage of traffic in both directions, and the substitution of a number of staffs at each end of the section. The staffs for any one section are all similar, and are of equal value; and these are contained in instruments, placed in the cabins, which are so constructed that only one staff can be withdrawn from the instrument for any section at a time. Whilst such an arrangement enables traffic to be more readily handled, and releases the rigidity of the simpler system, it is obvious that the precautions to be observed in such a method are necessarily more elaborate, and the control of the instruments containing the staffs must be absolute.

An interesting instrument, from an electrical point of view, for this purpose is Webb and Thompson's electrical train staff instrument which is shown by Figs. 86-88.

Fig. 86 shows front and side views of the exterior of the instrument with a number of staffs in position, together with the two switches, indicator, and bell key. Staffs can only be inserted or withdrawn from the instrument at the opening, H. Staffs may be *inserted* at any time, but can only be *withdrawn* under prearranged conditions.

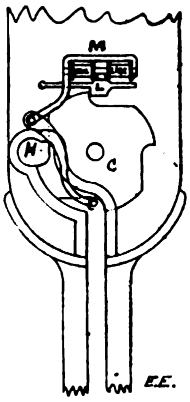

FIG. 87.

Fig. 87 represents the arrangement by which the staffs are locked in the staff pillar. The cam-wheel, C, turns on its centre. When a staff is raised with the object of withdrawing it, it must lift the bent lever, *l*, before entering the passage to H. The compound electromagnet, M, is lifted by the movement of *l*, and if it is energised *properly* it lifts the lock, L, with it. Otherwise L remains in the position shown. If L is raised with M the motion of the staff, under the movements of the signalman, towards H causes the cam-wheel, C, to turn, and allows the staff to pass to H, and be withdrawn there. In the event of M not being properly energised, L will remain as shown, and

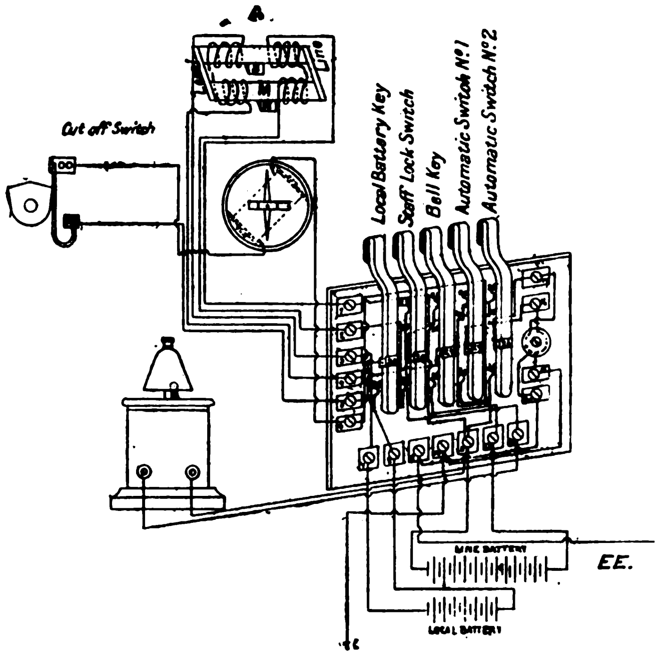

FIG. 88.—Webb and Thompson's Electrical Train Staff Diagram of Connections for One Section of Single Line.

the cam-wheel being locked against turning in the necessary direction, it will be impossible to withdraw the staff under the conditions. Obviously, therefore, the withdrawal of a staff depends upon the excitation of the magnet, M, whilst a glance at Fig. 87 will show that staffs may be put into the pillar at any time.

The instrument is provided with a switchboard (Fig. 88) of five switches, four of which are two-way switches,

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whilst the fifth has only one contact. The switches marked No. 1 and No. 2 are actuated by the movement of the cam-wheel (C, Fig. 87), and change the positions of contact every quarter revolution of C.

The switch marked "bell key" is actuated by the depression of the lever similarly lettered in Fig. 86. Normally the bell key (Fig. 88) makes contact at "23"; when the lever is depressed, contact is made at "33." The "local battery key" and "staff lock switch" bars (Fig. 88) are operated by the switch on the right hand of Fig. 86. When the handle is as shown by Fig. 86, the "staff lock" bar makes contact at "22" and the "local battery" bar is disconnected. When the handle is placed to "For staff" the "staff lock" bar makes contact at "32" and the "local battery" bar at "31." The cut-off switch (Fig. 88) is operated by the left-hand switch, shown in Fig. 86. When the indicator attached to the handle is in the position shown it does not affect the "cut-off" switch, shown in Fig. 88, but when held *hard* down in the position shown the spring is displaced from the upper stud, and the circuit broken. The indications "Staff in," "Up staff out," "Down staff out," of the left-hand switch do not depend in any way upon the actual conditions being similar to the indication exhibited. They are merely reminders which the signalman may or may not place in accordance with the actual state of affairs, without affecting the working of the apparatus. The staff lock electromagnet, M (Fig. 87), is shown diagrammatically in Fig. 88, and the construction of the indicating magnetic needle is shown in the same figure.

All train distinguishing and other signals passing between the signalmen at opposite ends of the staff section, are given by a bell code; the bell being rung by depressing the key shown on the front of instrument in Fig. 86.

(To be continued.)

MEASUREMENT OF POWER IN TWO AND THREE PHASE CIRCUITS BY MEANS OF WATTMETERS.*

BY DUGALD C. JACKSON.

The principles underlying the methods of measuring power in polyphase circuits differ in no essential respect from those relating to single-phase circuits, but it is desirable to apply them in such a way as to reduce the number of necessary readings to a minimum. For satisfactory measurements, non-inductive wattmeters are of essential importance, and very satisfactory commercial portable wattmeters are now to be had for a reasonable price. In the following *résumé* of the various ways in which wattmeters may be applied to the measurement of the power in polyphase circuits it has not seemed necessary to insert mathematical proofs of the soundness of the methods, as these have been fully set forth by such eminent men as Blondel, Gerard, etc.

Two-Phase Systems.

Independent Circuits.—In a two-phase system with separate circuits independent wattmeter readings are taken in each circuit, and the total power is the sum of the readings. One wattmeter placed in each circuit (illustrated in Fig. 1), from which simultaneous readings are taken, is the best arrangement; but if two wattmeters are not to be had one may be inserted successively in the two circuits, and the sum of the readings is equal to the power in the system provided the load does not vary while the readings are being taken. If the circuit is perfectly balanced, twice the reading of a wattmeter in one circuit is equal to the power, but this is a condition which cannot be relied upon.

Circuits with Common Return.—Two wattmeters may here be used, one for each circuit, connected in the way shown in Fig. 2, and the power in the system is equal to the sum of the readings. When the system is in exact balance the wattmeters may be connected as in Fig. 3, or one wattmeter may be used in the way illustrated in Fig. 4, but the condition of exact balance, as has already been remarked, is not to be relied upon, so that the arrangements shown in Figs. 3 and 4 cannot be safely used, except under exceptional conditions. When a single wattmeter is used in a balanced system, as illustrated in Fig. 4, the current coil is placed in the common wire, and a reading is taken with the free end of the pressure coil connected to one outside wire. The pressure coil terminal is then quickly transferred to the other outside wire and a new reading taken. The sum of the readings is then equal to the power sought.

* From the *Electrical World*, New York.

Three-Phase Systems.

Three Wattmeters.—(*a*) If the power delivered by a generator or absorbed by a motor or other device which is connected in star or Y fashion is to be measured, three wattmeters may be used, connected as shown in Fig. 5, provided the common or neutral point is accessible. It is

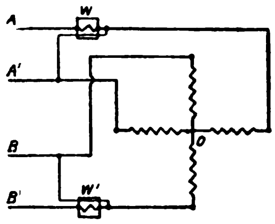

Fig. 1.

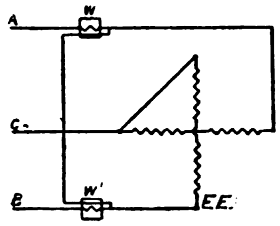

Fig. 2.

evident that each wattmeter measures the power in one coil, so that the sum of the readings gives the power in the system. If the system is exactly balanced three times, the reading of one wattmeter gives the power. (*b*) If the devices are connected mesh or Δ fashion three wattmeters can still be used, provided the current coils of the wattmeters can be inserted directly into the coil circuits, as shown in Fig. 6. The power in the circuit is equal to the sum of the three wattmeter readings, and if the circuit is

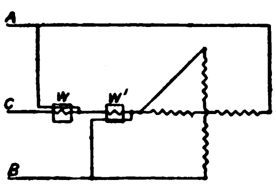

Fig. 3.

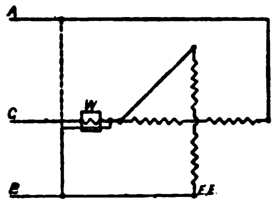

Fig. 4.

exactly balanced three times the reading of one wattmeter gives the power. (*c*) When it is impossible to insert the wattmeters in the coil circuits of a device with mesh connection, the three-wattmeter method may still be used by the creation of an artificial neutral point, as shown in Fig. 7. For this purpose one end from each of three equal non-reactive resistances are connected together, and the other ends are connected to the respective corners of the mesh circuit. If the system is balanced, the pressure

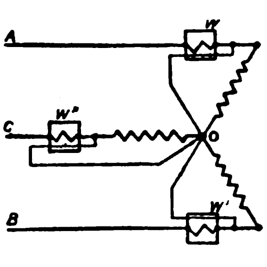

Fig. 5.

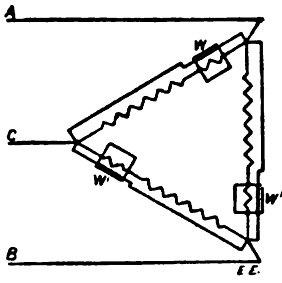

Fig. 6.

between the neutral point and either corner is equal to $\frac{E}{\sqrt{3}}$, where E is the pressure of one coil, and the phase of this pressure is ϕ degrees in advance of the current entering the corner. A wattmeter with its current coil inserted in the circuit wire leading to the corner carries a current equal to $\sqrt{3}$ C, and if the free end of the pressure coil is connected to the neutral point, the power reading of the wattmeter is

$$\frac{\sqrt{3}\, C\, E \cos\phi}{\sqrt{3}} = C\, E \cos\phi,$$

which is the power in the coil. This holds equally true for an unbalanced system. Care must be taken that the resistances of the wattmeter pressure coils are so large compared with the three auxiliary resistances that connecting them

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in circuit does not disturb the pressure of the neutral point. If the resistances of the wattmeter pressure coils are exactly equal, auxiliary resistances are unnecessary, and the measurement may be made by joining the free ends of the three pressure coils. The equality in the resistances of the pressure coils may be gained by inserting proper non-inductive resistances in series with them, as shown at r_1, r_1^2, r'' in Fig. 8. These methods are independent of the condition of balance in the system.

Two Wattmeters.—The algebraic sum of the readings of two wattmeters inserted in a three-phase circuit as shown in Figs. 9 and 10 gives the power in the system with entire

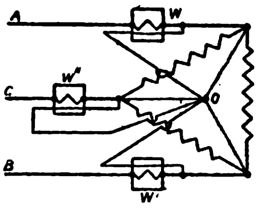

Fig. 7.

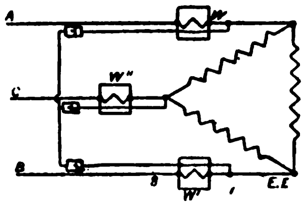

Fig. 8.

independence of the balance of the system or current lag; the only conditions affecting the soundness of this method are (1) when the devices are connected in mesh fashion, as in Fig. 9, the algebraic summation of the instantaneous pressures between the three lines, A, B, and C, must always be equal to zero, or

$$e_{AB} + e_{BC} + e_{CA} = 0;$$

(2) when the devices are connected in star fashion, as in

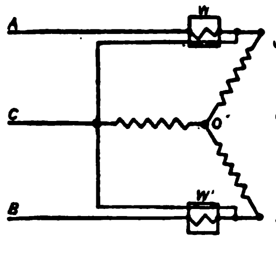

Fig. 10.

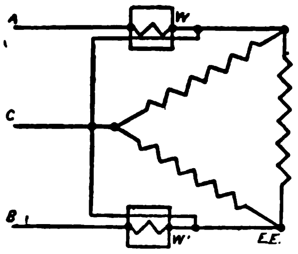

Fig. 9.

Fig. 10, the algebraic summation of the instantaneous currents in the three-line wires, A, B, and C, must always be equal to zero, or

$$C_A + C_B + C_C = 0.$$

When two wattmeters are used as here proposed, and the equivalent current lag in the circuit is less than 60 deg.—*i.e.*, the power is greater than ·50—the arithmetical sum of the readings of the two instruments is equal to the power in the circuit; but if the lag is greater than 60deg.—*i.e.*, the power factor is less than ·50—the relation of the currents

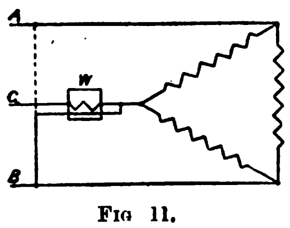

Fig. 11.

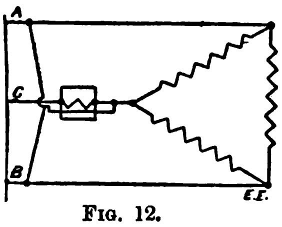

Fig. 12.

in the current and pressure coils of one of the wattmeters causes it to have a negative reading, and the arithmetical difference of the readings of the two instruments gives the power. There is some difficulty in distinguishing which condition exists in many cases, especially when the power absorbed by partially loaded induction motors (in which the power factor is low) is under measurement. As a general rule, if the conditions do not make the case evident, the truth may be discovered by interchanging the positions of the instruments without altering the relative connections of their current and pressure coils. If the deflections of both needles are reversed, the difference of the original readings represents the power; but if the deflections are in the same direction as before, the sum of the readings is correct. A double wattmeter, consisting of two fixed coils and two movable coils on one spindle, can be used in measuring power by the two-wattmeter method. Such an instrument of itself sums up the double reading algebraically, and a single reading gives the power. Recording wattmeters based upon this principle can be made very useful in the commercial sale of power from three-phase circuits.

One Wattmeter.—In a balanced circuit, one wattmeter may be very conveniently used by connecting the current coil in one wire and connecting the free terminal of the pressure coil alternately to the other two leads (Fig. 11), when the sum of the readings gives the power. For, the power reading of the wattmeter in its first position is $\sqrt{3}$ C E cos (ϕ + 30°), and in its second position, $\sqrt{3}$ C E cos (ϕ − 30°), and the sum of the readings,

$$\sqrt{3}\ C E \{\cos(\phi + 30°) + \cos(\phi - 30°)\} = C E\ 3 \cos\phi,$$

where C E and ϕ are the current, pressure, and lag in a coil; but C E cos ϕ is the power in one coil and 3 C E cos ϕ is the total power of the three coils, hence the one wattmeter gives correct indications *provided ϕ is the same for all the coils and the load is uniformly distributed.* A wattmeter having two independent pressure coils could be used as a direct-reading instrument for this purpose. A similar wattmeter could also be used in one-wattmeter measurements of power in two-phase circuit. An ordinary wattmeter with one pressure coil may be used for the double measurement at one observation by connecting the free end of the pressure coil to the middle of a high non-inductive resistance which is connected between the two lines opposite to the one in which the current coil is inserted (Fig. 12). This reading is evidently equal to the sum of the readings with the other arrangement, but the wattmeter constant must be determined with one-half the high resistances in series with it.

The conditions italicised above is ideal rather than practical, so that this arrangement cannot be relied upon, and either three or two wattmeters must be used according to the arrangements illustrated in Figs. 5, 6, 7, 8, 9, and 10, for the purpose of measuring the power in a three-phase circuit under operating conditions. The two-instrument arrangement is correct in nearly all cases, and, of course, is the most convenient.

PRESENT STATUS OF THE DISTRIBUTION AND TRANSMISSION OF ELECTRICAL ENERGY.*

BY DR. LOUIS DUNCAN.

It is my purpose to take up the different methods of transmission and distribution and to consider the limits that are actually fixed by the present status of electrical development. The question is a commercial one, each problem presenting different conditions which must be considered, but certain general principles govern each case, and our knowledge and experience makes it possible to judge the practicability of each particular transmission.

Generating Plants.—At the present time practically all of the electrical energy distributed is generated in plants operated either by steam or water power, and it is important to consider the conditions of maximum economy in large generating plants, as this bears directly on the subject of transmission and distribution.

Some of the latest steam plants have machinery of the highest possible efficiency, and yet if we consider the price per horse-power of the power generated we will find that it is greater than we expect. This is partly due to the fact that for both lighting and power purposes the load on the station is, as a rule, not uniform and the apparatus is not working under the best conditions for economy. If we take the load diagram of such stations in large towns, we will find that the average output is not greater than 30 to 40 per cent. of the maximum output. We have therefore to supply a large amount of machinery corresponding to the maximum demand on the station, while for distribution a large amount of copper is required that is only being used at its maximum capacity for a comparatively short period of the time. In stations supplying power for traction

* Presidential inaugural address read before the American Institute of Electrical Engineers, September 23, 1896.

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purposes we find a variation of load, but the variation is a different kind from that found in a lighting station. In the latter the load varies at different hours in the day, but for any particular instant it is practically constant. In the former the average load for different hours during which the station is operated will be practically constant, but there will be momentary variations depending upon the size of the station and the type of traffic. Taking, for instance, a 2,000-h.p. station in Baltimore, I find that the average load is 48 per cent. of the momentary maximum load. This difference in the kind of variation for the two types of stations necessitates employment of different apparatus to obtain the maximum economy for each type. For lighting stations triple-expansion engines may be used, while for traction work, where the variation in the load is sudden and may occur after the steam is cut off from the high-pressure cylinder, it is not well in general to go beyond compound engines, and there is even a question as to whether simple engines are not more economical when condensing water cannot be obtained. In any case, however, it is of the utmost importance as regards economy of operation that the load should be made as constant as possible.

Two distinct types of distribution are used for incandescent lighting in this country — the single-phase alternating current and the direct-current three-wire system. At the present time the former does not permit the supplying of power.

With the alternating system it seems impossible to provide even a moderately steady output, but with the continuous-current system the motor load during the day gives an average output greater in proportion to the maximum. Some years ago the question of the relative values of the alternating and direct current systems was discussed, and for a while most of the stations installed were of the alternating type. At present the tendency seems rather in the direction of continuous-current stations, especially in towns where there is a large demand for current within a comparatively small area. There is a great advantage of direct currents in that they allow the employment of storage batteries, which equalises the load on the station. The efficiency of batteries in lighting stations is comparatively high, while the depreciation has been greatly reduced, and is not now over 5 or 6 per cent. per annum. In most systems, however, the full benefit of the storage batteries is not realised, as the batteries are placed in the station, and while the advantage of an approximately constant load is obtained, yet the further advantage offered in distribution is not secured. I will take this question up later.

As far as traction stations are concerned, their efficiency and output would be increased by the use of batteries, both because the machinery would be steadily loaded and because the most efficient type of apparatus could be used, as is the case in lighting stations.

If storage batteries are used, the two types of variable load belonging to lighting and power stations demand different types of battery. For lighting stations a considerable capacity is required, while the momentary variations of power stations do not require any great capacity, but demand as great a maximum output as battery manufacturers can obtain.

In water-power plants the conditions of economy are different. The location of the plant is, of course, definitely fixed, and the advisability of obtaining a uniform load by means of batteries depends upon the local conditions.

We may conclude that while the practice in large lighting and traction systems is to multiply stations near centres of consumption, yet the economy of a single large station makes it important to consider whether it is not possible to concentrate our power at some point where the expenses will be a minimum, and distribute by some of the methods which have in the last few years proved successful and economical. It is important to make the station load steady, and this may be done for continuous-current lighting and traction plants by means of storage batteries.

Electrical Distribution.—I shall first consider the condition of affairs in a traction system in a large city where a number of suburban lines are operated. If direct distribution is attempted from a single station, it will be found that when the distance exceeds five or six miles a large amount of copper must be employed to prevent both excessive loss and excessive variation of potential on the lines. On suburban lines it is the latter consideration that usually determines the amount of copper used, and this is especially true on lines where there is a considerable excursion traffic. Even in the city itself the supplying of sections at distances three or four miles from the station may require so much copper that it would be less expensive to operate separate stations. Several methods other than the direct method may be employed to remedy these difficulties. For outlying lines where the traffic is mainly of the excursion order, being variable both during the day and for different seasons, boosters may be advantageously used. It is perhaps best from reasons of economy to run the boosting dynamos from motors. If the average station potential is 600 volts, and it is boosted 300 volts, then the copper for a given loss would be decreased in the ratio of 36 to 81. The booster system has the advantage of the direct system when the cost of the additional apparatus together with the increased loss on the line, capitalised, is less than the increased cost of the copper necessary to produce the same result by the direct system. Whether the balance is in favour of one or the other depends on the distance and the variation of the load, and it is indifferent whether the variation in the latter occurs often or not.

If any transforming device is employed to feed a distant section of the line, it must be remembered that the capacity of the device must be great enough to look out for the maximum demand on this section. Suppose now that we wish to feed some suburban line where the load has considerable momentary fluctuations, but where the traffic is moderately constant during the year. In this case the booster could be used with a storage battery at the end of its feeder, the battery supplying the line. The advantages of this combination are greater than with the simple booster, and in many cases they will compensate for the interest and depreciation on the battery and the loss in it. If the arrangement is properly made, the load on the booster and line wire will be practically constant, thus decreasing the capacity of the booster to that required for the average load, while less copper will be required for a given loss. As to the latter point, suppose a given amount of power is to be distributed in 24 hours, say 200 amperes at 600 volts; if the load is uniform, the loss will be proportional to $200^2 \times 24$ hours. If it is all distributed in 12 hours, the loss will be proportional to $400^2 \times 12$ hours, or twice as much. So in the case of the steady load the same power could be transmitted with the same loss with half the copper. It makes no difference whether the variation extends over 12 hours in 24 or it occurs every other minute, the result will be the same. It is apparent, then, that it is of the utmost importance to keep the line steadily loaded, as well as the station, and this points to the location of the battery near the points of consumption and not in the station. By this system—a booster with storage batteries—it is possible, assuming the same loss, to transmit power to a distance of 10 miles with approximately the same amount of copper that would be required for a five-mile transmission on the direct system. It would increase the economical radius of distribution twice and the area of distribution four times. A single station could economically supply lines within distances up to 10 or 12 miles. If it is desired to still further increase the radius of distribution, it is possible to do this by employing some of the alternating-current methods that have come into use. I will discuss these methods later, but at this point I may remark that the use of stationary and rotary transformers permits the energy to be transmitted in the form of alternating currents, and to be changed again into continuous currents of any required voltage. These rotary transformers supplied by an alternating current which is transmitted from the station at a high voltage may be used to feed the line directly, or they may be used to supply storage batteries which are connected to the line. In the latter case we have the advantage of decreased size of apparatus, of steady load on the station, and of a minimum cost of copper on the line; which system it would be best to employ would depend upon the distances and the character of the line and load.

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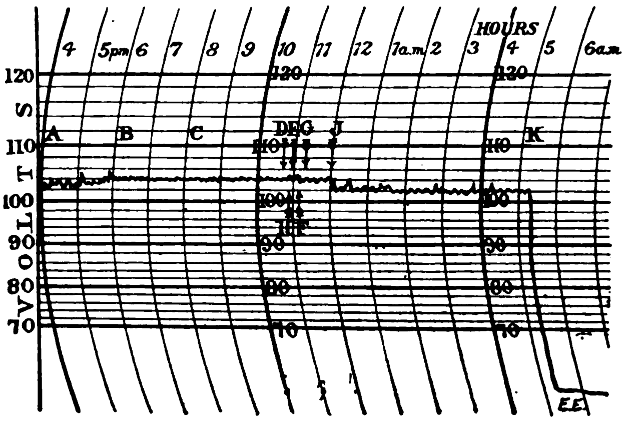
Of the systems that I have proposed for city and suburban distribution from a single station, three have been successfully employed—namely, the booster system, the booster system with batteries, and rotary transformers operating directly on the line. When we consider the advantages of a single station and a steady load it seems evident to me that many of the large traction systems would do well to concentrate their stations into one, and to use the booster system with batteries for their outlying lines, and if necessary use rotary transformers for lines beyond the limit of ordinary suburban work.

THE HASTINGS SWITCH GEAR.

We have received from Mr. L. Andrews the accompanying record of station voltage at Hastings. It shows the regularity of the supply, which is largely due to the use of the synchronising switch gear described in our issue of the 9th inst. The sudden fluctuations so often seen in these curves are, of course, primarily due to variation in the supply, but the magnitude of the recorded variation can be largely influenced by the recording apparatus. Inertia in the moving parts always magnifies sudden alterations of pressure, and, on the other hand, a too strongly damped needle may err in the opposite direction. The curve before us had evidently been inked in by hand before being photographed, and in this way the sharp character of the peaks is lost. Certain points, as G and F, do not in our reproduction show fluctuation, but in the print sent us faint



indications of three to four volt kick can be seen. Mr. Andrews informs us that the unsteadiness between A and B and J and K was caused by a faulty governor on the small engine. Then working 52 15-ampere arc lamps were switched on to the 'bus bars at B, and the regulating resistances were not touched during this operation. Between B and C two 100-unit machines working in parallel were doing between them 214 kilowatts. Between C and D the regulating resistances were never once touched. At 10.30 p.m., D, and again at 11 p.m., E, a machine was switched on to the 'bus bars, which are now always paralleled when the synchroniser lamps are pulsating very quickly. The fall in volts at 11.20 p.m., G, shows the effect of synchronising in the old way—viz., waiting for a long and steady phase. At 10·50 p.m., H, the field of one of the 100-unit plants connected to the 'bus bars was open-circuited. At 11.10 p.m., F, the automatic switch was made to cut out by shutting the stop valve of the engine driving the plant to which it was connected. It is now the usual practice at Hastings, when taking an alternator out of parallel, to shut down the engine and let the automatic switch cut out when the return current passes. We also received an interesting curve showing how soon the switch acts if a bad parallel is made. In the record we see that 3½ seconds after the connection was made the circuit was automatically interrupted owing to a return current, but unfortunately the recording curve does not show the magnitude of the current in question. If another curve given us is to the same scale the value would be about 50 amperes. These curves were taken by throwing a spot of light from an arc lamp on to a mirror attached to the spindle of a Shallenberger meter, the turning torque of which was opposed by a fine spring. The light was reflected from the mirror on to a sheet of rapid bromide paper, moved at a uniform rate by clockwork.

REVIEWS.

Examples in Electrical Engineering. By SAMUEL JOYCE, A.I.E.E. Longmans, Green, and Co. (Price, 5s.)

This is one of a class of books which, well done, possess great value. The mere reader or hearer is apt to be somewhat of a dreamer, and unable to apply his knowledge with exactitude. We are of opinion that although most teachers make much of written answers to questions, their much is far too little. There should be for every branch of industrial work requiring calculations books containing thousands of simple questions upon the subject. The greater the number of simple questions the better, and the more gradual the change made to more and more difficult the better. Practice makes perfect holds good here as elsewhere, and the student's practice ought to be so large and so diversified that when a new problem presents itself little time should have to be wasted in its solution. The making of the large number of examples for practice is no easy task. The writer thinks this or that so simple as to require but one or two questions. It is to him, but not to the learner. Further, there are thousands of students who have to "grind" out the work for themselves without the aid of a teacher, and to them specimen solutions are of the greatest value. To reason correctly is a gift not given to everybody, but many can follow in the same direction their guide leads them. Mr. Joyce, then, is a guide, and, so far as we have examined the book, a good guide. He solves a very large number of problems which may be taken as representative problems, and the knowledge of the way to solve them enables the student to solve similar problems when the terms do not vary too much. Mr. Joyce commences with the consideration of simple circuits, but he is careful to vary the conditions so that the problems cover most of the ground in practice. He then considers distribution and multiple-wire circuits, concluding this part of the subject with Chapter III., which discusses circuits containing more than one E.M.F. A running commentary, or explanation, leads up to each problem, and we must say that, not only in this section, but throughout the book, the problems solved are well chosen. It will not be necessary to deal at length with the chapters or sections, but simply to say that, following the circuits, we have chapters upon dynamos and motors, in which fields, armatures, magnetic circuits, efficiencies, etc., are illustrated. Here we would make a mild criticism. Is it altogether impossible for English writers to avoid using German or Old-English text letters in formulæ? Was it not De Morgan who made much of the right kind of paper and type to avoid eye-tiredness? It would, we think, be far better in these days of hurry to avoid everything that adds to the labour of the physical part of the student, and we think these letters used in formulæ are not distinct enough to avoid trying the eye. Then, again, it would be a boon and a blessing to men if letters were universally used to indicate the same thing, and not that every author followed his own sweet will. What we have said with regard to the unsuitable kind of letters in formulæ may be taken also to apply to the writing on diagrams. Unfortunately, far too many authors like writing with a flourish, which when reproduced and reduced in size photographically becomes almost, or quite, illegible. But to resume. Mr. Joyce considers questions of traction, alternate currents, transformers, capacity, resistances, etc.; altogether giving specimen solutions to some 63 problems, and then gives a list of over 150 more for the student to try and solve. The arithmetical answers to the latter, together with a number of useful tables, complete the book. We have, as stated above, examined a number of the problems solved, and must state that these solutions taken together with the explanatory matter ought to make the book a valuable one in the hands of all students.

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BOUND VOLUMES.

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CITY AND GUILDS.

This institution is assuming larger and larger proportions and becoming the principal centre from which practical technical education is radiated. The Science and Art Department occupies a sphere in education which is not well defined; it was in existence before the City and Guilds, hence the latter had to make a programme which took into account existing work. Such a programme would necessarily differ considerably from one constructed under absolute freedom of action. Thus, we have to consider the work of the City and Guilds Institute as it was possible to make it, rather than as ideally perfect. The report of the examinations department, which has just reached us, presents some curious reading, and suggests that the system possible is not so good as it might be. Take the following passages for comparison: "Since the issue of the last report the number of new teachers whose qualifications have been provisionally or permanently approved has been one hundred and forty-eight." Of course, we assume that all teachers have thus been approved. Now, turning to the report of the examiners on electric lighting and power we read: "The conclusion seems inevitable that in many cases the teachers who are conducting the classes are not engineers at all, but possess a book knowledge only of electrical work." Here, then, in the first place, all teachers are approved; in the second place, some of them are said to be incompetent. Whose is the fault? Surely not with the teachers, but with the men who have approved the teachers, or it may be with the examiners. In the first place, "teachers" as a rule cannot be practical men. They never have been and never can be. Their objective is "teaching," not practice. The examiners are teachers, not practical men. That is conclusively shown by their questions, some of which go far to make us believe that the examiners are just as unpractical in examining as they say the teachers are in teaching. The best teacher savours much of the interpreter. He is not expected, or ought not to be expected, to teach his students how to mix cement, to grind the valve of a gas-engine, to apply insulating material to wires, and so on, but to teach the principles involved in practical work. The actual doing of the thing is learnt in the shops, not in the schools. We could name many a professor, many a teacher, whose lectures and writings are most intensely practical, but who could no more compete with an ordinary mechanic in the management of a lathe than he could fly. We have said the best teacher is an interpreter: he sees the progress of practice, he sees how old principles are newly applied, and the latter knowledge forms the basis of his teaching. The difference between the later school of teachers and examiners and the older school is simply that the former teach principles with a view of their application; the latter taught principles with never a thought to their application. Analysis is probably the basis of most of the teaching of to-day; synthesis was probably the basis of the older teaching. But we are travelling somewhat wide of the report before us. We say it

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condemns its own actions in that it condemns some of the very teachers it has approved. Reference is made to the similarity of answers with "consecutive numbering." This seems small game for a weighty report. It is what we should and ought to expect, be the teacher good, bad, or indifferent. It will be seen that our idea of what constitutes a good teacher and the institute's idea are not the same. The institute says: "It is desirable that they should have spent sufficient time at their trade to have become skilful workmen; they must have some knowledge of scientific method—whatever that may mean — besides having received a fairly good general education." What would the great educationalists say to this view? Here and there you may find a workman born to be a teacher, but not frequently. The good teacher requires training and apprenticeship just as much as the good workman, and life is not long enough to undergo two apprenticeships. One great mistake of the City and Guilds Institute is that at the Central Institution, where good teachers are supposed to be framed and moulded, there is, so far as we know, no attempt to show the embryo teachers how to teach. The notion that any man or woman who is filled up with technical information or that has passed certain examinations is competent to teach, is an exploded fallacy, although it still seems to be the view of the institute. Lastly, no ordinary student can properly assimilate in one session any one of the three branches in the syllabus of "Electric Light and Power." The student may be crammed to pass—he cannot be taught; and this, again, is not the fault of the teacher: it is the fault of the organisation.

RECORDS.

The advance of the electrical industry is fast weeding out imperfect types in all departments. In the old days of dynamo design, for instance, every maker had his own shape of dynamo field, and often prided himself on the striking contrast between his machines and other dynamos. Experience and extended knowledge has tended to abolish these monstrosities of the early days of electric lighting. Still, these false steps on the road to success are worthy of record, and a museum containing examples of these early types of machinery would be of great interest and value. The men who can from first principles determine *de novo* what is right and what is wrong are few, and the great majority of engineers rule their course by practical experience. The faults and failings of old classes of machinery have from experience been found out, and the inspection of such discarded plant would keep the causes of such failings to the fore. The student or the practical man would in such a museum be able to study the steps in the perfection of any apparatus for a specific purpose. In this way the time expended by some in reinventing old types or in perfecting new apparatus on the trial and error system would be saved, and could be put to more remunerative purposes. Our readers will notice a letter from Mr. Clement E. Stretton on the formation of a museum for railway signalling apparatus. We agree with him as to the advantages to be derived from such an institution, but think that it might be a branch of the present Patent Office Museum at South Kensington. In the galleries of this museum several electrical exhibits are to be seen, and in some cases prominent electrical engineers have presented series of apparatus showing developments of the type now manufactured. The successive exhibits are clearly labelled with dates and short descriptions. These gifts to the nation are to be highly commended, and we hope to see the example largely followed.

HONOUR WHERE DUE.

The news that the King of Servia has created Prof. D. E. Hughes a Knight of the Royal Order of Takovo will be welcomed by all. The history of this eminent scientist is one of great successes followed by well-deserved honours. His inventions in telegraphy have been almost universally adopted, and it is most pleasing to find that this fact has been acknowledged by most of the ruling powers in Europe. The no less valuable invention of the microphone can also be claimed by Prof. Hughes, and in this case the discovery was given to the public gratis. We are able, through the courtesy of the newly-created knight, to give the contents of the letter from the Servian Ambassador which accompanied the Grand Officer's Star and Collar. The letter reads as follows:

Dear Professor Hughes,—It has been brought to the knowledge of his Majesty the King of Servia that not only the Servian State Telegraphs are employing the type-printer—the invention of which has so justly established your fame throughout the civilised world—but that at a certain period of your brilliant career you honoured the capital of Servia with a short sojourn, and were kind enough to explain the principles and mechanism of your invention to the Telegraph Department of State there. His Majesty, who takes great personal interest in the progress of physical science, was further informed of the important services which you have rendered to science and the world by your other inventions and discoveries. His Majesty thought that Servia owed you a public recognition of the services done her, as well as an expression of appreciation and admiration of services which you have done the whole world. Influenced by such sentiments, and believing that it would be an honour for the knights of the Servian royal orders to number you among them, his Majesty has been pleased to confer on you the Grand Officer's Star and Collar of his Royal Order of Takovo.

I congratulate myself on my good fortune in having been instructed by his Majesty, my august master, to convey to you his high appreciation of the services you have rendered the world at large, and in some measure also to Servia.—I have the honour, dear Professor Hughes, to be your most obedient, humble servant, (Signed) Ched. Mijatovich.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

HONOURS TO PROF. D. E. HUGHES, F.R.S.

Sir,—I am directed by his Excellency the Servian Minister to inform you that his Majesty King Alexander of Servia has conferred upon Prof. David Edward Hughes, F.R.S, the Grand Officer's Star and Collar of the Royal Order of Takovo.

His Excellency desires you will kindly state the reasons actuating his Majesty in conferring this honour upon the distinguished electrician—viz., that his Majesty, who takes great personal interest in the progress of physical science, has been especially interested in the type-printer which is employed by the Servian State telegraphs service, the

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invention of which has so justly established Prof. Hughes's fame as a great inventor; and, further, that his Majesty has informed himself as to other important inventions and discoveries of the learned professor, in particular the microphone, and his Majesty considered that Servia owed Prof. Hughes a public recognition of his efforts as well as appreciation and admiration of services which are of great advantage to the whole civilised world.—Yours, etc.,

H. W. CHRISTMAS,
Consul-General for Servia in London.

The Royal Servian Consulate-General in London, 42A, Bloomsbury-square, London, W.C., Oct. 29, 1896.

THE BLOCK SYSTEM.

SIR,—Having read with great interest the articles of Mr. J. Pigg (p. 456), I beg to ask that gentlemen to have the goodness to state when the block system was first introduced?

Every few years a person claims in all the papers that he invented the block system in 1865; but, of course, all railway engineers know that it was in use in its present form in 1853, and in other forms in 1839.—Yours, etc., CLEMENT E. STRETTON.

Leicester, October 26.

[We shall be glad if Mr. J. Pigg can give us any early history of the subject. Mr. Stretton's letter, however, appears to answer itself, and a copy of his collection of early records of the block system would be of great interest.—ED. *E. E.*]

A NATIONAL RAILWAY MUSEUM.

SIR,—Electric apparatus is such a very important part of railway working, that I beg to call your attention to the very great necessity which exists for the formation of a national railway museum in which all details of block systems, telegraph, interlocking, etc., could be preserved.

For ten and a half years I have urged the importance of such a museum, but at the present time there is every reason to believe that the required result will be attained, and as soon as it be formed it is my intention to present the whole of my large railway collection thereto.—Yours, etc., CLEMENT E. STRETTON.

Leicester, October 26.

RE INDIARUBBER INSULATION.

SIR,—From various quarters signs of restlessness arise as regards the present practice in wiring for electric light. Some authorities differ, and all of them—apparently with one accord—suppress their dogmatic wrath wherever they meet with bold, bad men who ignore or defy the Phœnix or minor "rules" which a year or two since none but the very elect dare run counter to. New rules are expected; and as it is the *un*-expected that is likeliest to happen, the electric lighting world is in a feeble state of agitation concerning the outcome. No better time can come for a review of the canons of authority on insulating materials. The best judges may be most surprised at what I wish to emphasise, but when I have placed a few pregnant facts in their natural order I have no doubt one or other of the few fit, fair, and fearless experts will take up the parable and point the moral.

Thirty years ago I found indiarubber condemned and out of use as an insulator, whilst guttapercha was everywhere in supreme favour. Secondary materials—such as Stockholm pitch, tar, paraffin wax, marine glue, and Chatterton's compound—had their uses and kept their places; indeed, they hold their own even now under ever-varying *aliases*, especially "Chatterton's compound," whose strongest mark of distinction is that it never was "Chatterton's," and that its component parts are not found in Chatterton's specification. Such is business. But the significance of this bald relation of facts consists in the ignominious confusion in which the whole question is involved. Practically and broadly speaking, after 30 years ringing the changes on the above materials we are "no forrader." This is no doubt owing chiefly to the manner and conditions under which electric lighting has occupied—almost monopolised—the stage. How does indiarubber stand in this connection? Thirty years ago I found the very reasons why indiarubber was put aside were the very reasons why it should have front rank in all but submarine insulation. All demand for it had ceased, and Silvertown had distinctly and emphatically thrown it over in favour of its great rival—guttapercha. Even the most strenuous resort to vulcanising did not save it. But having intimate acquaintance with the article in all its states, qualities, and conditions, I set up wire-covering machines and kept an old Silvertown wire coverer doing nothing but rubber-covered wire for all my electric bell work, and in 1873 Silvertown had to buy rubber-covered wire of me to supply importunate customers. I do not state this as any discredit to them or credit to me. I simply relate the facts to show that indiarubber, after being condemned and crushed by vast guttapercha interests, rose again by its own virtue under fair trial, and now, after figuring very largely in the electric lighting world, would die out "unhonoured and unsung" in a very similar way to that of 30 odd years ago. For look how it poses now. The same stage is arrived at as was reached in 1862. Wherever insulation of importance was wanted the sophisticated article was covered and "protected" with vulcanised rubber. The short respite soon ended, for who does not know that after three or four years' exposure to varying temperatures vulcanised rubber rots, and injures rather than protects its more tender though more durable *protégé*? Whilst waiting the next move it may be interesting to enquire if any of the consumers of the manufacture are aware that, although it is quite easy to obtain natural rubber covering in its pure unsophisticated state, there is not a bit in the market. In 1880, writing in the electrical Press, I said, after enforcing the superior claims of indiarubber over its rivals, "pure rubber, not the article which passes under the name, but which has all its virtue masticated out of it." I have specimens of elastic rubber, which have been in my possession 38 years, as sound as ever, and others—including some dentist's "dam" rubber only three years old—rotten as tinder. Whereas the natural rubber, cut into tape direct from the "bottle" or other crude form, is practically everlasting. Nor let anyone be led by the nose by the knowing ones, who would have you believe that it is impracticable *now* because of the wicked natives, who, in spite of Manchester and other morality teachers, do persist in loading the bottles with so much dirty grit that if the knives would cut the tape the tape would not be sound, and therefore worthless for the purpose. It is not true. The truth, is there is a *possible* saving of not more than 10 per cent., and a loss of efficiency about 30 per cent., and of durability about 99 per cent. As no one professes to use anything but best Para rubber for wire insulation, it may be as well, in anticipation of the objections currently bandied about, to refer to the well-known description of the Para rubber district, published under the title of "Fifteen Thousand Miles on the Amazon and its Tributaries," by Brown and Lidstone. The professional survey of the district by the authors, occupying several years, gave them an unparalleled opportunity for witnessing innumerable instances of rubber collecting and smoking, and I have the most positive assurance from one of the authors that there is no inducement for the collectors to let any grit or other foreign substance mix with the rubber, but rather the other way, for very practical reasons. This is further corroborated by the manager of one of the large rubber-manufacturing companies, who from 40 years ago down to the present time has known no difficulty in getting virgin rubber sound and solid, fit for cutting tape direct from the crude bottle.

Now, to save a possible 10 per cent.—really an unnecessary allowance if wire-coverers would only look to the credit of their craft—a loss of more than half its value and nine-tenths of its natural life is submitted to by using rubber that has been through the "masticating machine," and still further ruined by a chemical solvent.

This matter is of such paramount importance that many well-informed lay members in the electrical world are looking for a little scientific accuracy to be applied to it. Perhaps the society will move in the matter.

At first sight it may seem strange that if there is so

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much difference in the insulation value between the rubber cut direct from the bottle and that which passes current amongst experts as pure Para rubber no one should have made a stir about it. It may be as well to review the points involved in this strange situation. The electric lighting boom, which culminated in 1882, got no impetus from any great invention or discovery in the insulation of wires. The experts in lamps and dynamos were content to take to indiarubber insulation as a tried servant with a good character, and the assurance of wire-coverers that they used none but best pure Para rubber was probably quite *bonâ fide*, and no one on examination would be likely to dispute it.

It need not be surprising that the article known everywhere in the trade as the purest and best should pass muster. Yet all along the fact remains that no indiarubber that has gone through the masticating process, or has been dissolved in any liquid, can be truly said to be pure in any sense worth placing in the category of scientific accuracy. The moment the question is raised in a critical spirit, which is the proper spirit for such a question, it will be seen how caution is suggested by the first step in the departure from nature. It sounds very rough and ready to hear that when the Zeringa juice is tapped from the tree it is collected on a mould and smoked layer after layer. Yes, smoked! But what smoke; and why will not *any* smoke do? Surely here is a case where caution is indicated if only one kind of smoke is found to suit. From this stage forward scientific accuracy is cast to the winds—the only scientific accuracy observed being the formula laid down by the South American Indians of past centuries. It may not seem practicable to stick to the Indian formula only for wire covering, else the obvious plan would be to let the wire serve as the mould, and get the Indians to run the wire through the milk and smoke in a running line. It would be much simpler than the present plan and more economical, for the smoke "sets" the milk quickly enough for a raw Indian to do about three miles of wire a day, and a uniform thickness at that. The only item that does not work out right is, who is likely to have pluck enough to believe in such a simple solution, and no patent rights in the way, too? Meanwhile, the question here at home is, what is to be done? For supposing it is true that the only way to get long-lived rubber covering is to cut the tape direct from the bottle. Are there no contingencies to count on, such as frost, etc.? My reply is *no* to all the idle queries all down the line. And here is the reason for raising the question now. Every electrical catalogue gives chief position to indiarubber as a wire insulator, and every week in one or the other of the electrical journals there are accounts of breakdowns from faulty insulation. Yet no distinctive pronouncement as to whether we have or have not a safe material for long-lived insulation. If not indiarubber, what other material is there to take its place? Time has been required to confirm or confute the claims of the numerous new nostrums that have been and gone quicker than leap years. Leaving this as the outcome—viz., guttapercha a good second, indiarubber only a good first, when qualified by a vulcanised outer, and only that because the time trial is not over. The outsiders are still taking care of the favourites, and by their aid "hope" still "tells a flattering tale" and makes good business. Even with them the trouble is to tell where and when their turn comes; fancy is so free, and system so carefully avoided. But would it not be feasible to borrow a little science from the turf and try to handicap the well-known public performers—to wit, Stockholm tar, linseed oil, resin, paraffin wax, gum Damara. Mixtures of these, without mentioning members of any other allied gums, may be varied in so many plausible ways that the first attempt to give proper weight to their respective merits would need severe trials to prove them. Probably the only combination that offers any present opportunity for the requisite "sacredness of accuracy" to have "a look in" is that which passes under the name of "marine glue," but even in this case great care at the outset is needed, for there have been several variations always in use to suit various purposes. And when all that could be hoped for could be attained, a thorough realisation of how evanescent the spirit that binds these matters together would strongly emphasise the importance of making sure whether we have or have not in indiarubber a unique, simple, and truly natural material that contains within itself all the qualities which the smartest efforts would desiderate. As for vulcanising it to save it there are numbers of good trustworthy judges accessible to any man of business in a serious mood who will accentuate the futility of expecting *that* to preserve its homogeneity. The purest and in every sense the most perfect specimen of vulcanised rubber—probably unmatched for carefulness in its production—is a book with thin creamy flexible leaves, bound in carved ebonite, that was got up for presentation to her Majesty the Queen by Charles Goodyear, the inventor and perfecter of the process. This was done and accepted by the Queen in 1856, and the leaves will prove which lasts longest—the natural or the manufactured article, for in the same collection are specimens of the raw material. This is a practical court of appeal, if other facts are too evasive. But all difficulty will probably disappear if the parties most interested in the matter will only bend to the occasion and look carefully into it.

Meanwhile, the only alternative resort is in metal sheathing or concentric wiring (line inside and outer for return), for that is a protection that will greatly lengthen many short-lived materials. As the electrical world has had this plan before it since I first specified it in 1873, it presents another instance of hope deferred and the slow growth of sound practice. At its best, however, it must leave so much branch wiring to be done with more pliable conductors that the opening problem will need solution. I conclude with the modest challenge that my solution holds the field; and I can refer to buildings wired 30 years ago with miles in each of single, double, and treble rubber coverings that will bear out the claim.

Since all these considerations ought to have some more or less definite relation to the "rules," "Phœnix" or "Institute," I refer with perhaps pardonable satisfaction to my criticism of them in 1882, as not only have my forecasts proved true, but there still remain vexing dicta with little apparent help over difficulties, emphasised, but not elucidated, as "rules" should in some measure indicate.

The final query that will crop up may as well be met at once. It will be asked, can a simple test be applied to prove whether one really gets the natural, unsophisticated article when insisted upon? The answer is emphatically *yes*, for if it deceived the eye it would not deceive the touch or the handling when its differential characteristics were once pointed out.—Yours, etc.,

Camberwell. WALKER MOSELEY.

PURE OR APPLIED SCIENCE.

SIR,—The "Catalogue of Scientific Papers" compiled and published by the Royal Society of London was intended to serve as an index to the titles and dates of scientific papers contained in the *Transactions* of societies, *Journals*, and other periodical works. This catalogue is highly valuable to all technical enquirers, and it is a matter of deep regret that the international conference held under the auspices of the Royal Society of London has decided that the international catalogue of scientific literature, which is to begin with 1900, is to relate to pure science only, applied science being strictly excluded. It is possibly too late to remedy the position, which is probably due to absence of representatives of technical societies at the international conference.

It would seem desirable, further, that there should be a conference of technical societies to discuss the publication of a subject-matter index to technical and scientific periodicals. This institution has had for some time before it the question of the publication of such an index of subjects of interest to mining and metallurgical engineers; and probably a comprehensive index to engineering and other technical papers would prove more valuable.

This suggested conference of technical societies might also consider other questions which interest technical societies individually, but which they are unable to obtain owing to want of concerted action. Thus, such an association might approach the Government on such questions

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as the excessive cost of postage of *Transactions*, as there can be no valid reason why they should not be placed in the same position, although their *Transactions* are issued at varying intervals of time, by a short Act of Parliament as an ordinary weekly newspaper.

And there are many other matters which no doubt crop up in connection with the carrying out of the objects of individual societies in which concerted action would produce valuable results.—Yours, etc.,

M. WALTON BROWN, Secretary.

The Federated Institution of Mining Engineers, Newcastle-on-Tyne, October 21, 1896.

A DISCLAIMER.

SIR,—It has come to my knowledge that reports have been circulated that I am acting as consulting engineer to the Mile End Guardians. I shall be obliged if you will allow me to state that such is not the case, as my appointment with Messrs. Crompton and Co., Limited, prevents my acting in such a capacity.—Yours, etc.,

B. H. JENKINSON.

TECHNOLOGICAL EXAMINATIONS.

We have received an advance copy of the report on the work of the examination department of the City and Guilds of London Institute. The general features of the educational scheme are referred to in our leader, but the following abstracts of the examiners' reports on electric subjects will be of interest to our young subscribers:

Telegraphy and Telephony.—A noticeable feature of the examination is the still further advance made in the number of candidates who have entered for the telephony paper, this total being 53 against 31 for last year, or an increase of 21. The increase, however, it may be mentioned, has not been entirely at the expense of the telegraphy paper, as the number of candidates who attempted the latter was 80, against 89 last year, or a diminution of nine only. The interest in telephony has doubtless been very largely due to the fact that the telephone system of the United Kingdom is gradually passing entirely into the hands of the Postal Telegraph Department, the members of the staff of which presumably form a very large proportion of the total number of candidates examined. In the honours grade in telegraphy the percentage of failures has not materially changed, being 26·2 per cent. against 27·0 per cent. for 1895. The telephony results are not quite so good as regards percentages, though the actual number of candidates who passed first class is actually greater than in 1895, being 26 against 23; and this also applies to the second class, the numbers being 17 and 6 respectively for 1896 and 1895. Taking the examination as a whole, I think the results are not unsatisfactory, though there are indications that the training of the candidates who attempted the ordinary or pass grade leaves something to be desired. Take, for example, Question 2, which is definitely laid down in the syllabus as a subject for examination; very few indeed of the candidates had any idea of what is meant by an "absolute galvanometer." Question 6, which was attempted by many, and which was set as a test of general education, was answered incorrectly in almost every case. Question 15 produced a group of curious answers, very few indeed of the latter even approaching correctness. This question at least, it might have been expected, would not have been beyond the knowledge of the majority of the candidates.

Electric Lighting and Power.—The examiners have been struck with the exceedingly bad quality of the sketches and diagrams in the answers both to the preliminary and to the ordinary papers. Candidates do not seem to have had any proper training in making dimensioned hand sketches, nor in the correct methods of drawing electric circuits. The examiners also note that a very large proportion of the failures arise from the unreal nature of the information possessed by the candidates, and from the parrot knowledge which so largely does duty for an acquaintance with the subject. Candidates who cannot give simple answers to quite elementary questions in the technics of the subject, and waste their energies in calculating to many places of decimals numerical deductions from data having only three significant figures, cannot be regarded as qualified to receive certificates of efficiency in this branch of engineering. The conclusion seems inevitable that in many cases the teachers who are conducting the classes are not engineers at all, but possess only a book knowledge of electrical work. Such an inference is confirmed by the occurrence amongst the answers of batches of answers of which the consecutive numbering shows that they come from the same school or centre, wherein, in spite of the wide choice given to candidates from which to select, there is a lamentable failure to attain even a second-class pass. The percentage of passes in the honour grade is much higher than in the ordinary grade, and of the honours passes more than half are of first-class quality, whereas in the ordinary grade not only more than half the candidates totally failed, but of those that passed the greater part only succeed in obtaining a second class; the number of answers that are good enough to qualify for a first-class ordinary certificate being relatively very few. In this respect there is a distinct falling off in the answers as compared with previous years. In Branch III. of honours, dealing with central-station work and electric traction, there is a decided improvement both in the number and quality of the answers; but in Branch II., dealing with dynamo construction and allied subjects, the answering is poor and the number of papers small.

Electro-Metallurgy.—The high standard of last year has not been maintained, but the papers show a fair average of knowledge, and a large proportion of those who pass are in the first class.

The fact that instructors without practical experience cannot impart real technical knowledge must be evident to all, and the institute has this matter in their own hands to remedy.

LOCOMOTIVES ON HIGHWAYS ACT.

The motorcart regulations of the Local Government Board have not yet been issued, but as the Board has forwarded draft copies to all the county councils of England and Wales, the metropolitan vestries, and all other highway authorities, the nature of the regulations is a very open secret. A motorcar, or "light locomotive," is defined as a "vehicle propelled by mechanical power which is under three tons in weight unladen, and is not used for the purpose of drawing more than one vehicle (such vehicle, with its locomotive, not exceeding in weight, unladen, four tons), and so constructed that no smoke or visible vapour is emitted therefrom, except in temporary or exceptional circumstances. If a car exceed 3cwt. in weight, it shall be capable of being so worked that it may travel either forward or backward, and whatever its weight it must not exceed 7½ft. in width, measured between its extreme projecting points. As to tyres, the order says that if a car weighs between three-quarters and one ton, the tyres must be not less than 2½in. wide; if between one and two tons, 3in.; and if between two and three tons, 4in. There must be no bosses or projections, except in the case of pneumatic tyres. Every car must be provided with two independent brakes in good working order, and so powerful that if the car is travelling at the rate of 14 miles an hour it can be stopped within a distance of 50ft. As in the case of ordinary vehicles, the name and address of the owner must be written upon the side of the car, which must be driven by a person competent to control it. Lamps must be carried at night, and it is required that the driver shall, whenever necessary, give audible warning of the approach of the car. The driver must also, on the request of any police-constable, or of any person having charge of a restive horse, cause the car to stop, and to remain stationary so long as may be reasonably necessary. On the subject of speed the Local Government Board, after reminding the highway authorities that the Act provides that motorcars

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shall not be driven at a greater speed than 14 miles an hour, states that it proposes to make no order regarding the question of speed until the general regulations have come into operation.

INTERNATIONAL SUBMARINE TELEGRAPHY.

With the sub-title of "A Protest," the following appeared in the *Pall Mall Gazette* on Wednesday:

"The proposed international memorial 'To the Inception and Extension of Submarine Telegraphy' appears to have created some stir, and a good deal of correspondence in the *Times* concerning the justice of especially associating with it the names of the late Sir John Pender, Sir James Anderson, or Mr. Cyrus Field. The official letter from the secretary—said to be 'authorised,' but certainly not by his committee generally—sounded very much like dropping a hot poker. We shall be exceedingly surprised if the scientific men whose names have been made use of (on the committee) in connection with this scheme consider it an honour to have their departed chiefs and fellow-workers 'tacked on' to the above three names in any secondary position. It would seem that, if any three names are set up as the pioneers of submarine telegraphy, they should be those of men who have rendered it an accomplished fact by engineering skill and electrical devices rather than three financiers of this branch of scientific enterprise; the more so when we remember that submarine telegraphy could not possibly be financed until there was something practicable to finance. Lord Kelvin, the late Sir Charles Bright, Sir Samuel Canning, the late Mr. T. R. Crampton, the late Dr. Werner von Siemens, the late Mr. Cromwell Varley, Mr. Latimer Clark, and Mr. F. C. Webb are all pioneers of this work in a strictly professional sense, though none of them has made the large fortunes out of it that the financiers have been able to. We are of opinion that a memorial to such as these would be infinitely more suitable, for it is their early accomplishments which have enabled the capitalists to amass these very fortunes.

"In the event of a memorial being erected to the sister branch of engineering, we find it hard to imagine that Lord Stalbridge, Lord Emlyn, or Lord Tweedmouth—as chairmen of the three largest railway companies—would put themselves in a false light by posing as the pioneers of our railways. And yet there would be just as much sense in this (or in that of immortalising Hudson, the 'railway king') as in putting forward the names of Sir John Pender, Sir James Anderson, and Mr. Cyrus Field as representatives of the inception and extension of submarine telegraphy. Just now, civil engineers seem to be having a bad time of it. On the one hand they are constantly elbowed by the Royal Engineers out of work that distinctly pertains to the civilian; and, on the other, commercial men show signs of laying claim to glory and honour that certainly belongs to the civil engineer."

APPLIED ELECTRO-CHEMISTRY.*

BY JAMES SWINBURNE.

LECTURE IV.

(Continued from page 468.)

Again, if hypochlorites or chlorate get to the cathode they will be reduced wastefully. But these are conditions that would not occur in a rationally conducted works. If you put salt into a vat and stir it round during the electrolysis, the result will obviously be that very soon hypochlorite will be formed in large proportions at the anode to be reduced again at the cathode. But then nobody tries to make soda and chlorine that way. Suppose, however, that the liquid is still, and there is a porous partition. Start with all chloride. Chlorine comes off at the anode and hydrogen at the cathode, and caustic appears at the cathode. We now have, in the anode compartment, chlorine moving towards the anode, and sodium towards the cathode. In the immediate neighbourhood of the cathode we have both caustic and chloride. We thus have the current there borne by the sodium moving towards the cathode, and also by hydroxyl ions moving towards the anode, and chlorine ions moving towards the anode. Eventually the hydroxyl ions will reach the porous partition, and they will finally go on into the anode chamber, and we shall there have caustic which will take up chlorine and make hypochlorite. This, I take it, is Dr. Hurter's difficulty. If the current were borne entirely by the sodium and chlorine, all the chlorine would eventually move into the anode chamber, and all the sodium would move into the cathode compartment. In practice, however, we have to run brine into the vats continuously, and run off caustic solution. The ionisation of the caustic and salt depend on the strength of the solution with regard to both. I need not take actual figures, as it will serve my purpose to suppose for the moment that all the current is borne by the hydroxyl, the chlorine and both lots of sodium ions being idle and not migrating at all. Of course in the anode chamber, where I assume no caustic for the moment, the current must be borne by the chlorine. Then we have a sort of army of hydroxyl ions marching from the cathode towards the anode at a certain rate. We admit the brine to the anode compartment, and we draw off caustic liquor from the cathode chamber. Then all we have to do is to feed the brine at such a rate that the whole of the liquid moves at the migration velocity of the hydroxyl. The hydroxyl then really stands still and never gets to the anode. What is drawn off is really a mixture of salt and caustic. The vat has full efficiency, as hydrogen comes off at the cathode and chlorine at the anode. The current being borne by the hydroxyl makes no difference in the current efficiency of the vat, as the current borne by the hydroxyl is just as effective as that borne by the sodium or chlorine ions. The real difference is in the amount of salt it is necessary to draw off with the caustic. If the current were all borne by the chlorine, we could get pure caustic solution off. The relative ionisation of the salt and caustic affect the proportion of salt and caustic drawn off, and thus influence the cost of finishing; but they do not affect the current efficiency. I hope I have not misrepresented Dr. Hurter in any way.

In the case of making chlorate, all that is necessary is to feed the potassium chloride in at the cathode end, and draw off the chlorate at the anode. The same vat gives either product, according to the direction of the fluid current. Of course the chlorate vat must be hot, and as the anode liquid is not acid, platinum anodes are available. I tried small chlorate vats on this principle some years ago, but have made very few and imperfect experiments on caustic soda.

COPPER REFINING.

There is but little to be said about copper refining or the electrolytic extraction of the metal from its ores. A great deal has been published about refining, and still more about various schemes for extraction, and there would be little use in repeating such accounts here. At the same time, there is a great deal—as Badt points out—that is not published. Copper refiners seem to think they are working a magic secret process, and that if they keep all the details to themselves no others will be able to compete with them. Such ideas are commonly to be found among workmen, but are seldom encountered among educated people; and the probability is that the various copper refiners are working their processes as badly as they can be worked, and understand very little about electrolytic work. The unfathomable secret guarded by copper refiners seems to be the use of anodes and cathodes of copper in a solution of copper sulphate. As regards details of management or of processes, such as the best temperature to work at, or the best method of circulating the liquid, there can be very little to learn. It would be much better, however, for electrolytic copper refiners to publish results and compare notes, as if they are competing with one another any knowledge shared equally among them makes no difference, but it puts them all in a better position as competitors in the race with refiners who use ordinary metallurgical methods. The same sort of thing went on in early days among incandescent lamp makers, and, in fact, it still goes on. Fortunately, workmen are migratory, and wander from factory to factory, so that each factory knew what the others were doing, but thought its own processes were profound and valuable secrets. The more insignificant the works, and the more idiotic the process, the greater was the secrecy observed.

The main difference between two classes of copper refining processes consists in the series or parallel coupling of the plates. From a purely electrical point of view, this looks like a distinction without a difference, but there is more in it than appears at first sight. It makes little difference in the energy used per ton of copper refined, the only source of divergence being the numerous contacts in the parallel system. When a vat only takes a fraction of a volt, a large proportion of the power may be wasted on imperfect contacts.

The series arrangement, however, saves a good deal of money in the leads, and greatly simplifies the connections. It is often supposed to have some magic efficacy in giving a greater output of copper for a given power, but that is absurd. Its great

* Cantor lectures delivered before the Society of Arts.

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advantage really lies in its needing less copper in the vats for a given output. This may seem a small matter, but if prices are worked out it may mean a very important saving. Take an example. Suppose copper is deposited at, say, five amperes per square foot; and suppose the anodes are cast, say, ⅝in. thick, and are eaten off both sides. Roughly, the anodes will take two months to be deposited on the cathodes. Take the case of a refinery dealing with a thousand tons of copper per month. This means that 2,000 tons are in the vats. As a matter of fact there will be a little more, but we can take 2,000 tons as a good round figure. The value of this copper at £60 per ton is £120,000. Now the question is, what value is capital to the owners of the refinery? They might perhaps be able to borrow money partly on the security of the copper at a low interest; but it is more likely that money is worth 6 per cent. to them, or, in other words, that their works give 6 per cent. on the capital sunk, and would give at least that interest on any further money sunk safely in enlargement. The interest on the copper in the vats is thus £7,200 a year, or £600 a month. As the output is 1,000 tons a month, this means that the price of refining copper is increased no less than 12s. a ton for interest on the metal in the vats. It is then of great importance to keep down the amount of copper going through the works—that is to say, to make it go through quicker. A little can be done by removing the cathodes when they are ⅜in. thick instead of ⅝in. and putting new ones. This reduces the 12s., not to 6s., but to something above 9s.; how much above 9s. depends on the cost of the initial cathodes. Many people may say there are such quantities of copper all about a copper refinery that it makes no real difference whether it is in the vats or in the stores. This argument is fallacious, for the copper in the vats is not available to fill orders like the finished copper in the stores. The stock of crude copper is merely a kind of buffer or regulator to take up the variations in supply, and give a constant feeder to the refinery: the stock of finished copper is to enable a slow and steady production to cope with sudden and irregular demands. The copper in the vats cannot act in either way, and is quite independent of the stocks held, and it cannot be drawn upon. It therefore represents capital lying idle. It is still an open question whether the series arrangement, as series arangement, saves money. At the Bridgeport works in Connecticut, which are I think the largest electrolytic copper-refining concern in the United States, the system worked out by Hayden is used. The anodes are rolled and are quite thin. I forget the dimensions just now, but think they were about ⅛in. when I saw them. They were arranged in wooden vats taking something like 120 volts, connection being made to one at one end, and to a special cathode at the other. Each of the intermediate plates then becomes both cathode and anode, as one side of it is eaten away, while the other has copper deposited on it. As the plates are rolled they are eaten and deposited very evenly, and the process is carried on till very nearly the whole of the copper is transferred. As the deposited copper never sticks tight to the plates, the remains of the original anodes can be picked off the refined copper. There is, of course, a certain amount of scrap anode which has to be remelted and rolled again, but as no leads have to be connected to the anodes, and as they are finally supported by the deposited copper, they can be consumed much more completely than in the case of thick cast anodes. The saving is thus essentially in the use of thinner plates, and in the cost of doing away with the necessity for making electrical connection to each plate with its attendant loss of power, due to inferior contacts. The saving in leads about the vat-house is also considerable. The most important of these points is undoubtedly the thinness of the plates in the vats. There seems no reason, however, why equally thin plates should not be used in the parallel system. There is no reason why the parallel system should be tied down to cast anodes, which must be fairly thick to allow of casting. It might be possible to cast the anodes thinner by adding a little extra silver. I have heard that a very little silver allows copper to be cast well, but do not know if that is correct. The silver would practically all come out again in the refining. Whether a trace of aluminium would do is another matter. It would, of course, be lost, and would gradually accumulate in the bath. These are merely crude suggestions. The series arrangement has been worked out, no doubt independently, by Smith, Hayden, and Stalmann. Who invented it, I do not know. It is described in a pamphlet by Hugon, dated 1885, but I do not know that any copy came into England or America until several years later. Hugon discusses the question of economy of capital sunk in copper going through the process; in fact, it is his main point, and he makes out that the series arrangement is cheaper, but it is difficult to see why, unless the series arrangement alone allows thin anodes and cathodes to be used. Hugon also discusses the use of cuprous chloride. Cuprous chloride gives twice as much copper as cupric sulphate with a given current; but that is not everything, and unless the resistance of the vat is so low that twice the pressure is not necessary, this does not pay. It might be said that a specially low current density might be used, but that means sunk capital again. I do not know at all how far the chloride would do, as it might carry over impurities that remain in the slimes in a sulphate solution. Copper nitrate gives good deposits of copper with enormous current densities, but it is probable that silver and, perhaps, gold are carried over. Swan has made numerous experiments on rapid deposition from the nitrate, but has, I think, published nothing as to its use in refining argentiferous copper. The presence of a very little chloride might prevent silver coming over, but it would hardly stop gold.

Stalmann, who was for some time manager, and who designed the Anaconda electrolytic copper refining works, uses a very ingenious series arrangement. Each plate has paper stuck to one side. A few copper rivets are put through, and the paper is blackleaded. This gives a paper cathode, which separates the deposited copper from the crude, and gives no trouble in separating the scrap anodes from the good deposited cathodes.

It is often supposed that everything electrolytic is pure. Unfortunately, this is not necessarily the case. Electrolytic copper is nearly pure, but it is generally, if not always, contaminated with antimony. It is probable this small trace of antimony does harm, as it most likely reduces the conductivity appreciably, and may alter the non-electrical physical properties of the metal. Antimony can be separated from copper by electrolytic analysis. What is wanted is a method which is possible on a commercial scale.

By the way, there is no space here for a discussion of electrochemical analysis, but there is just room for an urgent appeal to analysts not to measure electrical quantity in terms of bang-gas. Until quite lately, electroplaters and writers on electrolysis used the Smee cell as the unit of everything. When they told you they had passed the current of 57 Smee cells through anything, they thought they had given you information. The Smee cell, as a fundamental unit of everything, still lives in the somewhat muddled minds of many writers on electrolysis and electroplating of the old school. But in electrochemical analysis—which is a new branch of science—surely we might expect chemists to work with volt and ampere meters, and to use the methods of other scientific men.

Calcium Carbide.

This compound has created an enormous sensation in the financial world, or at least in the speculative part of it, during the last year or so. As far as its discovery in America goes, it appears to have been a mere matter of chance, an invention in the literal meaning of the word. The formation of calcium carbide from carbon and lime seems to be a mere question of temperature, and to have nothing to do with electrolysis. It may be that lime and carbon do not react until the lime is fused or the carbon volatilised, and that the temperature of the electric furnace is needed to bring this result about. It is probable, however, that the very high temperature is necessary to bring about the reaction, apart altogether from getting the lime and carbon into contact. I have tried some experiments with an oxygen furnace, and have not succeeded in making calcium carbide even when I used a solvent for the lime, so that there was no doubt that it came into contact with the carbon. These experiments were not tried thoroughly enough to be conclusive, but they tend to show that an exceedingly high temperature is needed. It is hardly necessary to say that an oxygen furnace—that is to say, an ejector furnace fed with an oxygen and coal-gas blow-pipe—gives a pretty high temperature.

The future of calcium carbide depends very largely on its cost of manufacture. It is, of course, very absurd to take the cost of coal, lime, and energy, and calling that the cost of the carbide, to compare the cost of a candle-power hour with that of gas as charged to the consumer. The prime cost of gas as delivered into the "hydraulic main" would be the right thing to compare in such a case, and would tell a very different story.

(To be continued.)

THE RATHMINES TRAMWAYS.

The question of the proposed purchase of the tramways by the Township Commissioners is exciting a good deal of discussion in this large suburb of Dublin. The Commissioners have held several meetings in connection with the subject, and a long letter has appeared in the *Freeman's Journal* from Mr. W. M. Murphy. At the last meeting of the Commissioners a lengthy report by the Parliamentary Committee was adopted, and a resolution to promote a Bill in Parliament authorising the Board to raise funds to purchase the tramways was carried with only three dissentients. The report was as follows:

Referring to the meeting of the Rathmines Commissioners on the 13th inst., when the question of the purchase of the tramways

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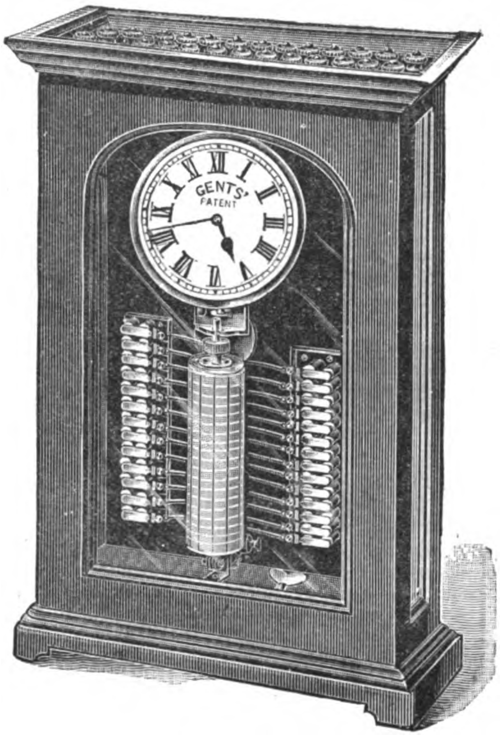
in the township was considered, it appears to us that the question as a whole is misunderstood. We, therefore, feel it to be our duty to lay the matter clearly before you. By the action of the Legislature, the tramway company were granted the user of certain of the roads within the township for their undertaking for a period of 21 years, free of charge, which period expires in the year 1899, and the Commissioners will then become entitled to purchase the tramways by merely paying to the company the then value, "exclusive of any allowance for past or future profits of the undertaking, or any compensation for compulsory sale, or other considerations whatever." Seeing the very large amount that the present company and the late Dublin Southern District Tramway Company were prepared to offer the city and this township for even the right of user of the roads, would the Commissioners be discharging their duties to the ratepayers if they allowed to slip their rights to obtain such a valuable property? The true way to look at the matter is to see what was done elsewhere. Take the instance of Glasgow, where the Corporation took over the tramways. The accounts for the year ended May 31, 1896, show a profit of £70,000, after paying all working expenses and interest on capital, and after the reduction of fares to ½d. per half-mile. Take, again, Belfast, where the Corporation took advantage of the powers placed in their hands, and, as a result, were able to re-lease the system to the old company for a further period of 14 years at a rent of £5,000 per annum for the first seven years and £7,000 for the second period of seven years. There is nothing whatever to prevent the Commissioners dealing with the tramways the same way. It would be altogether a matter for the future consideration of the Board whether they would work the trams themselves or re-lease them. With these facts before us, we say most emphatically that the Commissioners would be wholly neglecting their duties as custodians or trustees of the ratepayers' property if they allowed such a certain means of deriving a revenue to the relief of the rates to fall through. We are perfectly confident that the township would derive a very considerable advantage by taking over the tramways. The tramway company have never shown the slightest consideration to the township, the control of the roads by the company is very embarrassing, the Commissioners have found it very hard to get on with the company, and the Commissioners have incurred losses on account of the action of the company—for instance, the Commissioners some years ago purchased a piece of ground at the request of and for the convenience of the company, on the promise that the company would take it up and pay for it. The transaction cost the Commissioners something like £800, but the company repudiated their obligation to pay, and, in fact, have not paid a penny on account of this sum. Again, the Commissioners have had to appear before Parliament on two or three occasions consequent on the action of the company, at a considerable expense, and one penny on account of this has never been paid. If the Commissioners purchase the tramways, this would prevent the repetition of any such expense, and they would then have complete control of the roads. In 1895, when the company was before Parliament for a Bill for electric power, the company refused the slightest concession to the Commissioners or to the Corporation of Dublin, or to Pembroke Commissioners, though these bodies were willing to treat with the company at the time, but no concession would be made by the company. That Parliament believed that the local authority were to purchase the tramways is made clear by the fact that for the protection of the mortgagees it was enacted that "every mortgage granted by the company under this Act shall be endorsed with a notice that such mortgage will not be a charge upon the tramway in the event of its being purchased by the local authority under the forty-third section of the Tramways Act, 1870." If this provision has not been complied with it is not the fault of the Commissioners. We also fear that the question as to the waterworks is not fully understood. It does not need the skill of an actuary to prove that it is a profitable investment. The estimate for the works was £100,000; the actual cost of constructing the works was £165,000 (not three times the amount of the estimate of £100,000, as stated by a member of the Water Committee); £165,000 at 4 per cent., including sinking fund and interest, would amount to an annual charge of £6,600 for a supply of water equal to 3,000,000 gallons per diem. Had the Commissioners accepted the offer of the Corporation for equal supply of Vartry water, made in the year 1877, the township would be paying at the rate of over £9 000 per annum, which sum would increase annually as the township enlarged, which it is rapidly doing, and without reaping any advantage from the revenue derived by the township from outside supplies. Subsequently in the year 1879, when the Commissioners had determined to promote a Bill in Parliament for their own supply, the Corporation made an amended offer, but even this would entail an annual increasing payment of £7,562. 10s., whereas, the Commissioners having their own supply, every additional house that is built in the township, instead of increasing lowers the contribution towards the expense of the water supply on all other property; that with the increased revenue derived from outside supplies (at present bringing in about £750 per annum), so that now the waterworks are, as the Lord Chairman of the House of Lords (when allowing Section 57 into the 1893 Act) expressed his opinion that money authorised for waterworks should not be considered as a debt, but as a profitable investment. Thus it will be seen on the one hand, if the Commissioners had accepted the Corporation supply, they would be paying a perpetually increasing revenue to the Corporation, whilst, on the other hand, the Commissioners having their own water supply, the charge at the end of 20 years would be almost nil. It must always be borne in mind how fortunate it was, not alone for the inhabitants of this township, but also for the city and surrounding townships, that Rathmines had its own supply in the water famine year of 1893. If the Commissioners had their supply from the Corporation it would have fallen short early in the summer, and the result would have been an awful water famine all round. In our opinion it is for the advantage of the township to proceed with the Bill, and we recommend the Commissioners and ratepayers to do so."

TELL-TALES.

We publish an illustration of an improved dry ink marking tell-tale manufactured by Messrs. Gent and Co., Faraday Works, Leicester, for checking the movements of night-watchmen in warehouses, factories, mills, hotels, etc., and also ensuring the attention of night-nurses and attendants in asylums, hospitals, workhouses, and other institutions. Underneath the cylinder and running parallel with its axis are the markers, the number of these, also the length of the cylinder depending upon how many stations it is desired to communicate from. Each marker is operated by an electromagnet, so connected that when a comparatively weak current is sent through its coils the marker jumps up and strikes at the record sheet on cylinder. Between the markers and the cylinder is an ink-ribbon which is so fixed that every time a marker strikes a clear indication is printed on the record sheet opposite the



name of station which controls the marker and in the hour space corresponding with the time the movement is made. After each night's work the printed record is removed and a clean one put on.

COMPANIES' MEETINGS AND REPORTS.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY, LIMITED.

The half-yearly meeting of this Company was held on Wednesday at Winchester House, E.C., Mr. J. Denison Pender presiding.

The **Chairman**, after a reference to the late Sir J. Pender, moved the adoption of the report, a summary of which appeared in our columns last week. Mr. Pender said that the strong position of the Company was clearly shown, and he saw nothing in the future to diminish its prosperity. The receipts from messages, £92,071, showed a decrease of £14,097, as compared with the previous year; but this decrease was due chiefly to unavoidable and, he hoped, temporary causes. Among these might be mentioned the fall in exchange in Brazil, the dulness of trade, and keen competition in the River Plate district, causing fewer messages to be transmitted; while Press messages had increased, entailing much work, but not much additional revenue. Most of the commercial messages averaged only a little over nine or ten words. Above all, the decrease in revenue was due to a reduction of 6d. per word having been made in the messages to South America last year. On the other hand, their expenses were £19,210, a decrease of £2,413, due to the absence of any expenditure for the repair of cables, which in the previous year cost

£2,770. The dividend and bonus to be paid out of profit equalled 7 per cent.—the same as in the preceding year, and their reserve fund now stood at £832,000.

Mr. Youle seconded the motion, which was agreed to.

EASTERN EXTENSION TELEGRAPH COMPANY.

The half-yearly ordinary general meeting of the shareholders in the Eastern Extension, Australasia, and China Telegraph Company was held at Winchester House, E.C., on Wednesday, Lord Tweeddale presiding.

The **Chairman**, in moving the adoption of the report, a summary of which has been already given, referred with regret to the loss which the Company had sustained by the death of their late chairman (Sir John Pender), and pointed out that the gross revenue for the half-year under review amounted to £313 914, showing an increase over the corresponding period of 1895 of £49,776. This was undoubtedly due in a great measure to the gold-mining industry of Western Australia The working expenses were £87,256, showing a decrease of nearly £8,000 on the corresponding period of the previous year. Two quarterly interim dividends of 1¼ per cent. each, amounting to £62,500, had been paid for the half-year, leaving £108,235, of which £75,000 had been transferred to the general reserve fund, and the balance of £33,235 was carried forward.

The report was adopted.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Karlsruhe.—The Granducal Railway authorities will receive tenders on November 9 for the supply of a quantity of telegraph posts.

Bressoux-lez-Liege (Belgium).—The Municipal Authorities are prepared to receive propositions for public lighting by (coal) gas, electricity, or acetylene.

Bucharest.—Tenders will be received at the Mairie, Bucharest, on November 16 for two stand-by steam-engines for a water-power electric generating station at Grozavesti.

Malines (Belgium).—Tenders will be wanted for the supply at Malines of about six tons of special lubricating oil for dynamos and gas-engines. Particulars at the Brussels Bourse, where tenders will have to be sent.

Schneidemuhl (Germany).—Tenders are advertised for the supply of iron telegraph poles for the State Railways. Particulars for 50 marks (6d.) from die Königliche Eisenbahn Betriebsinspection, Schneidemühl, Germany. Tenders must be in by Nov. 5.

Ayr.—The Electric Lighting Committee invite tenders for the supply and erection of boiler and engine house plant. Specifications (price £2. 2s , returnable on receipt of bona fide tender) can be obtained of Mr. Robert Hammond, Ormond House, Great Trinity-lane, London, E.C., on and after November 10. Tenders to be delivered by November 25.

Cologne.—Tenders are required by the Municipal Authorities for the construction and working of electric tramways in the city of Cologne to an aggregate length of 20·3 kilometres (12½ miles). Specifications, plans, and particulars are obtainable for 10 marks (10s.) from der Registrateur B, des Oberbürgermeisteramt, Köln, Germany, and tenders must be in by November 6.

Paris.—Tenders will be received by the Post and Telegraph Authorities at Rue de Grenelle 103, on November 10, for the supply of Baudot telegraphic instruments (five lots), also messengers' wallets (three lots). Application for permission to tender must be made before October 30. On November 20 tenders will be received for the supply of various parts of telegraphic instruments for the next five years. Application must be made before November 10.

Warrington.—The Cheshire Lines Committee are prepared to receive tenders for the supply during the year 1897 of telegraph materials, instruments, wire, etc. Patterns can be seen and specifications with forms of tender obtained on and after November 2, 1896, upon application to Mr. S. Saxon Barton, storekeeper, Cheshire Lines, Warrington. Tenders, sealed and endorsed, to be sent to Mr. Glegge Thomas, secretary, addressed Cheshire Lines Stores Department, Warrington, not later than 10 a.m. on November 28 next.

Glasgow.—The Police Department of the Corporation invite tenders for the construction and erection of fans and motors for the new sanitary chambers, Cochrane-street, Glasgow. Specifications and forms of tender may be had and drawings seen on application at the office of Mr. William Arnot, electrical engineer of the Corporation, 75, Waterloo-street, Glasgow, and tenders, properly sealed and marked outside "Tenders for Fans and Motors," must be lodged with Mr. J. Lang, clerk, City Chambers, Glasgow, by 10 a.m. on November 9.

Monmouth.—The Town Council invite tenders for (1) machinery (consisting of turbines, alternators, steam-engines, boilers, electric motors, sewage pumps, etc); (3) cast-iron pumping main ; and (4) electric lighting mains. Plans may be seen on application to Messrs. Bramwell and Harris, engineers, 5, Great George-street, Westminster, S.W., or to the Town Clerk, Monmouth, from either of whom may be obtained, on deposit of £2 2s. (to be returned on receipt of a bona fide tender), a printed form of specification and tender for either contract. Tenders, on the prescribed form, must be delivered with the specification attached (enclosed in a sealed envelope), endorsed "Sewage-Disposal, Tender for Contract No. —," and addressed to Mr. T. R. Oakley, town clerk, Monmouth, by 12 noon on November 2.

Torquay.—The Town Council require tenders for the supply and erection of the following plant: (Section A) boiler-house plant—boilers and fittings, forced-draught apparatus, feed storage, etc ; (B) engine house plant — steam alternators, condensers, pumps, steam and exhaust pipes, etc., ; (C) switchboard, etc ; (D) underground mains, lamp-posts, etc. ; (E) transformers, etc ; (F) meters ; (G) accumulators, etc. ; (H) crane, etc.; (I) builder. Tenderers are at liberty to tender for any section or sections, but not for part of a section. Specification, with terms and conditions of tender and contract, may be obtained of Mr. W. H. Trentham, consulting engineer to the Council, 39, Victoria-street, Westminster, S.W., or of Mr. Fredk. S. Hex, town clerk, Town Hall, Torquay, on payment of £3. 3s., which sum will be returned on receipt of a bona fide tender. Tenders must be addressed to the Town Clerk, sealed and marked "Tender for Electricity Works," and delivered by 3 p.m. on November 3.

West Ham.—The Town Council require tenders for the supply of the following: four steam alternators and exciters; surface condenser and pumps; station switchboard, etc.; high and low tension mains, etc.; transformers, sub-stations, etc.; instruments; arc lamps, posts, etc.; crane. Plans of the suggested arrangements, specification, form of tender, and further particulars may be obtained at the office of Mr. John J. Steinitz, borough electrical engineer, Town Hall, Stratford, E., on the deposit of a £5 Bank of England note, which will be returned on receipt of a bona fide tender. Tenders, endorsed "Tender for Machinery, etc.," to be sent to Mr. Fred. E. Hilleary, town clerk, Town Hall, West Ham, by 4 p.m. on November 24. The contractor will be required to enter into a bond, with two sureties, for the performance of contract, and no work will be ordered under the contract until such bond has been duly executed. The contractor whose tender is accepted, and with whom a contract is entered into, will be required to pay the whole of his workmen such rate of wages and observe such hours of labour as are recognised by the workmen's trades unions and in force at the time of signing the contract. In the event of any breach of such agreement the Council will enforce the penalty clause in its entirety.

RESULTS OF TENDERS.

Barnstaple.—The Town Council have instructed Mr. W. J. Ridd to connect the police station and waterworks by the telephone.

Cork.—For the electric lighting of the Palace Theatre of Varieties the tender of Messrs. Handley and Shanks has been accepted.

Armagh.—The Asylums Board have accepted the tender of Messrs. Cox and Walker for providing the electric light to the County Armagh Lunatic Asylum, at £1,070.

Birkenhead.—The Town Council have accepted the tender of Messrs. J. Gordon, Allison, and Co., Limited, for the electric installation of the Central Free Library, at £89.

Stettin.—The lowest tenders for telegraph posts for the Prussian State Railways were those of Messrs. Cornin, Vallentin, and Marckwold, and the Berliner Holzcomptoir for various sizes of posts.

Antwerp.—The first firm on the published list of tenderers for the supply of electric lighting carbons to the Belgian State Railways at Antwerp, and to whom the contract will probably be given, is Bierordt, of Rotterdam.

Brussels.—The following were the lowest tenders for telegraphic supplies to the Belgian Government on October 21: galvanised iron wire, Dekoning and Co., Brussels, 17,085fr.; cables, Felten and Guilleaume, 19,674fr.; copper wire, E. Yung, St. Josse Ten Noode, 16,841fr. There were no tenders from English firms.

BUSINESS NOTES.

Sheffield.—The electric lighting is being taken up very extensively in High-street and the centre of the city.

Scotter.—There is a proposal to extend telegraphic communication to this town and also to the adjacent town of Messingham.

Brentford.—An offer to the District Council by Mr. Druce of an electric lighting scheme has been referred to the Works Committee.

Callender's Cable and Construction Company.—The Company have declared an interim dividend of 4s. per share, equal to 8 per cent. per annum.

Kettering.—In the Urban Council estimate for the half-year appears the item: electric lighting (balance of cost of provisional order), £70. 5s. 6d.

Dublin.—The Corporation are going to take the Pigeon House Fort, on the edge of the river, as an electric station, from which to light the whole city.

City of Birmingham Tramways Company.—Letters of allotment for the issue of first mortgage debentures and preference shares have been posted.

Shafton.—The clerk to the Parish Council has been instructed to make enquiries as to whether it is advisable to apply for telegraphic communication.

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Morecambe.—The District Council have decided to apply for an electric lighting provisional order, in case the one obtained by the company will not suffice.

Somerset.—It was reported at the meeting of the County Council that a contract had been entered into for lighting with electricity the Cotford Asylum at a cost of £3,000.

Dundee.—The directors of the Royal Lunatic Asylum have decided to introduce the electric light into the institution and the farm buildings attached thereto at a cost of £3 000.

Egypt.—Lord C. Beresford, in a speech at the Constitutional Club on Wednesday, remarked on the improvements in railways and telegraphs in Egypt since the British occupation.

Bath.—A Local Government Board enquiry is to be held to-day (Friday) in respect to the application of the Urban Authority to borrow £58,000 for the purchase and extension of the electric light works.

Chile.—According to *El Mercurio*, it is proposed to utilise the Maipo River as a motive power for electrical purposes and the propulsion of the Santiago tramways by electricity at a cost of £800,000.

Bury St. Edmunds.—Judging by the candidates nominated, the endeavour of the Ratepayers' Association to fight the municipal elections on the question of electric lighting has completely collapsed.

Russia.—It has been decided, says Reuter's St. Petersburg correspondent, to lay a telephone line between that city and Moscow. The cost of construction is estimated at 400,000 roubles (about £50,000).

Derry.—Mr. Christie, electrical engineer, has reported to the Lighting Committee as to the question of keeping the electric lamps alight all night. He says that it would cost over £400 a year if they adopted such a plan.

British Thomson-Houston Company.—The head office will for the future be at 83, Cannon-street, E.C. The Company's London workshops, testing-rooms, and stores are now situate at Rose's Wharf, 63, Bankside, S.E.

Gorleston.—It is stated that the Gorleston and Southtown Tramway Company are seeking corporate sanction to extend their line from Pier-walk to the vicinity of the south pier, and to apply electricity as a motive power.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending October 25 amounted to £1,092, as compared with £1,075 in the corresponding week of the previous year, being an increase of £17.

British Pure Acetylene Gas Syndicate, Limited.—This Company has been registered, with a capital of £50,000 in £1 shares, to acquire all patents, concessions, etc., for the manufacture and supply of gas, to supply electricity, etc.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ending October 23 were £1,988. 5s. 4d., compared with £2,045 14s. 10d. for the corresponding period of last year, being a decrease of £57. 9s. 6d.

Watford.—In our last issue we stated that the electric lighting proposal was deferred for 12 months, but, as a matter of fact, the amendment to this effect was lost, and the report of Mr. Hawtayne on the scheme, which is likely to cost about £20,000, was adopted by 11 votes to 2.

Hartlepool.—At a special meeting of the Town Council the Lighting Committee recommended that a provisional order be obtained, at a probable cost of £300 or £400, for the electric lighting of the borough. After some discussion, the matter was deferred until next year.

Leeds.—A plan has just been issued from the city engineer's office showing the existing tramways in the city, the routes of the proposed new tramways, and the roads along which the Corporation have obtained parliamentary powers to lay down lines but have not yet decided to do so.

City and South London Railway.—The returns for the week ended October 25 were £1,003, compared with £977 for the corresponding period of last year, being an increase of £26. The total receipts for the half-year 1896 were £15,696, compared with £14,678 last year, being an increase of £1,018.

Bournemouth.—The Lighting Committee having considered the question of lighting the main roads with incandescent gas lamps, recommended that the surveyor be instructed to report as to the cost of lighting the principal thoroughfares, the Lower Pleasure Gardens, and pier with electric light. The Town Council have adopted the suggestion.

Scandinavian Art and Industrial Exhibition.—The preparations are being made for the Scandinavian exhibition, to be opened at Stockholm on May 15, 1897, in connection with the twenty-fifth anniversary of King Oscar's reign. The object is to represent the artistic and industrial products of the Scandinavian countries and of Russia.

Acton.—At the District Council meeting a letter was read from the secretary of a motorcar manufacturing company stating that they had commenced to make scavenging carts fitted with motors. He would be pleased to quote prices for such vehicles, with full particulars, to the Council in a short time. The communication was allowed to lie on the table.

The Transvaal.—Application has been made by the Rand Central Ore Reduction Company to the Government for a site on which to erect chlorination works in the Barberton district, where they should prove of the utmost value, as the concentrates and complex ores produced cannot be treated in the district, and in many cases are not rich enough for shipment.

Southwark.—The clerk reported at the Vestry that he had had an interview with a representative of the Telephone Company, who had pointed out that the Vestry's proposal as to rent for the underground wires was really prohibitive. It was agreed that the matter should go back to committee for reconsideration.

Amsterdam.—The Dutch Government has decided to operate the large locks at Ymuiden, the outer port of Amsterdam, by electricity, and has placed the contract for the supply and erection, with the necessary plant, with Messrs. Schuckert and Co., of Nuremburg, Germany. It is stated that altogether 36 electromotors will be required, ranging from 17 h.p. up to 45 h.p. each.

Tonge.—At the meeting of the Parish Council a letter was read from the town clerk of Bolton with reference to the extension of tramways into the district by the Bolton Corporation, and a resolution was ultimately passed that the Council are in favour of the borough of Bolton promoting a Bill in the next session of Parliament to include the extension of the tramway through their township.

Personal.—Mr. C. A. Gibson, of 74, Hadley-street, Kentish Town, having been nominated by the London Trades Council, has been appointed by the London County Council a member of the Technical Education Board, in the place of Mr. Morgan.—Mr. J. H. C. Brooking has joined the staff of Messrs. W. T. Glover and Co., and is now superintending the laying of their cable in Shoreditch.

Calcutta.—A consignment of special small plants for jute press lighting has just been received by the Oriental Telephone and Electric Company, of 89, Clive-street. Each plant consists of one of their Norwich dynamos to run 22 16-c.p. lamps, 22 16-c.p. Edison-Swan lamps in special enamelled iron shades with special brass dust-proof holders, wire and cable dust-proof switches and safety cut-outs.

Coventry.—The Coventry Electric Tramways Company propose to apply for parliamentary powers next session to extend their present system by about 6¼ miles. At the last meeting of the company it was decided to approach the Corporation with a view of making arrangements that will enable the company to commence the proposed extensions as early as possible after parliamentary sanction is obtained.

Middlesbrough.—At the meeting of the Streets Committee of the Corporation, the proposal of the Imperial Tramways Company to introduce the electric tram system in Middlesbrough was referred to, and the Town Clerk said he had received from the tram company a statement of the alterations they proposed to make in Middlesbrough. After some discussion it was decided to hold a special meeting to consider the matter.

Why Trade Goes to Germany.—At the Blackburn Chamber of Commerce, a letter was read from a leading Lancashire firm of chemical manufacturers, stating that crude materials are conveyed from England to Germany for less than half the rates charged for carriage to Lancashire, and that while it costs 30s. to carry a ton of manufactured chemicals from Lancashire to London, the same goods are brought from German works on the Rhine for 12s. 6d.

Ayr.—The additions to the electric lighting works are likely to take a more extended form than was at first contemplated. In view of the liberal way in which the electric light is being adopted, it is thought that plant should be laid down to fill up the whole available space in the engine-house. Mr. Robert Hammond, the consulting electrical engineer of the burgh, has prepared specifications for two sets of plant, each capable of generating current for 6,600 lights.

St. Pancras.—At the Vestry meeting it was reported that owing to increased and increasing demands for the electric current it was necessary to provide a separate main, extending from Cleveland-street to Gower-street, Euston-road, and a new main was also requisite along the north side from Tottenham Court-road to Gower-street. Among recent applications for current was the London and North-Western Railway Company, who required additional lamps for Euston Station.

The London Tramways Scheme.—At the London County Council meeting the Highways Committee again brought up their report, the particulars of which were given in these columns last week. The committee recommended the Council to purchase the lines of the North Metropolitan and London Street Tramways Companies, and to lease them to the former company for 14 years. The consideration of the report was adjourned until next week for consideration by the Finance Committee.

Stoke-on-Trent.—The town clerk reported at the Town Council meeting that he had received a notice from Messrs. Milward and Co., solicitors, of an intended application to the Board of Trade for the transfer of the undertaking authorised by the Potteries Extension Tramways Order, 1896, from the promoters to the British Electric Traction Pioneer Company, Limited. He was instructed to communicate with the neighbouring authorities with a view, if possible, of some combined action being taken.

Wimbledon.—At the Urban District Council meeting it was agreed that certain negotiations suggested by the County of London Electric Lighting Company should be declined, and a draft provisional order in relation to the electric lighting scheme was approved. If this district is to be satisfactorily lighted, there seems no alternative but to adopt electric lighting. The gas has been so bad as to be of little use, and when meeting on the 21st inst. the District Council had to have the Council-room lit with candles.

Llandudno.—A letter was read at the District Council meeting from Messrs. Dickenson and Co., Birmingham, asking for the support of the Council to their scheme to construct an electric

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tramway connecting Colwyn Bay, Llandudno, and Conway, and intimating that Colwyn Bay had approved of that scheme. Several members opposed it, but on the casting vote of the chairman it was decided to consider the plans when submitted. It is proposed to erect a disinfector in connection with the projected electric light station.

Bolton.—During the past week the four new arc lamp pillars at the corner of the Town Hall-square have been placed in position. Each of the new lamps will have an illuminating power of 3,000 candles. The Gas Committee have decided to improve the lighting arrangements in a number of thoroughfares by erecting new lamps and rearranging others. A letter was read from the Board of Trade intimating that they would accept the accounts relating to the electric lighting department made up to March 31 instead of December 31.

Burton-upon-Trent.—At the annual meeting of the Staffordshire Institute of Mining and Mechanical Engineers, Mr. J. Settle, in his presidential address, referred to the recent application of electricity for relighting miners' safety lamps by electricity without opening them, which removed the risk of the lamps being unlocked in the mine and the possibility of one not being properly put together after relighting. Under proper regulations the system seemed commendable on the ground of economy and safety.

Messrs. O. Berend and Co.—Messrs. Berend have registered their business as a company under the title of O. Berend and Co., Limited. The management will remain in the hands of the hitherto partners of the old firm, who will become sole managing directors, while the business will be carried on as heretofore, and all debts due to and owing by the old firm will be received and paid by the new company.

St. Olave, Southwark.—At the meeting of the Board of Works, Mr. Smith moved: "That the Board accept the terms of the London Electric Supply Corporation, Limited, to make the necessary connections from their main for the purpose of lighting the Board's offices with electric light at a cost of £25, and that the clerk enter into the agreement for the supply of electrical energy at the rate of 6d. per Board of Trade unit, and for payment of the necessary meter rent." The matter was referred back to the Works and Finance Committee.

Western and Brazilian Telegraph Company.—At a meeting of the Board of directors it was decided that after placing £5,000 to the debenture redemption fund and £3,000 to the reserve fund, the directors would, subject to audit, recommend at the forthcoming meeting a dividend at the rate of 2 per cent. per annum, free of income tax, for the six months ended June 30 last, carrying forward £3,530. 5s. 7d. The receipts for the week ending October 23, after deducting 17 per cent. payable to the London Platino-Brazilian Company, were £2,432.

Telephonic Facilities.—The Postmaster-General has addressed a letter to the Liverpool Chamber of Commerce in continuance of correspondence on the subject of telephonic facilities for trunk lines. The Postmaster-General intimates that arrangements have been made by which subscribers may use a trunk wire for a second period of three minutes with giving previous notice. This concession is in response to complaints from mercantile men that the three minutes originally allowed for communications—including the time occupied in "ringing up"—was inadequate.

University College, London.—Evening classes in electrical engineering will be held on Tuesday evenings, 7-9 30, and in mechanical engineering on Monday evenings, 7-9.30. A course of about 20 advanced demonstrations is now being given in the electrical engineering laboratory at University College, Gower-street, W.C. Applications for admission to the class should be made to Prof. J. A. Fleming, F.R.S. A course of mechanical engineering is being given in the same college by Prof. T. Hudson Beare, B.Sc., M.I.C.E., on Monday evenings at the same fee. Full particulars are given in an advertisement in another column.

Belfast.—At the meeting of the Corporation the application of the Street Tramways Company for leave to establish a system of overhead electric traction was considered in committee. The following amendment to the original resolution was moved by Councillor John M'Cormick and seconded by Alderman Henderson: "That the further consideration of electrical traction be deferred for the purpose of the Law and Improvement Committees appointing an expert on tramways to report on the question generally, financially, and otherwise." The amendment was carried by 14 votes to 9, and the committee rose.

Stirling.—By invitation of the Police Commissioners, Prof. Kennedy has visited Stirling, accompanied by Mr. Mackenzie, convener of the Lighting Committee of Edinburgh Town Council. In company of the Electric Lighting Committee of the Commissioners, they made a tour of the town and suburbs, and in the afternoon met the Commissioners in a body. The proceedings were private, but it is stated on good authority that the professor's opinion was that Stirling, from its situation near the coalfields, and its other advantages, was peculiarly well adapted for the introduction of the electric light, with a good prospect of success.

Brighton.—The Works Committee recommend that the National Telephone Company be permitted to place their wires underground in several streets on payment of £1 per annum for the concession. The work of extending the electric light supply still goes on, and it is now recommended that additional mains be laid in Stanford-avenue, St. Andrew's-road, Preston Park-avenue, and Albion-hill It is considered inexpedient to put arc lamps in Beaconsfield-road or the upper part of Stanford-avenue. The Town Council have received notification that the rate of insurance on the Corporation generating station is to be raised to 10s. 6d. per cent. per annum, but the insurance company have undertaken to reconsider the proposed increase.

Halifax.—Mr. Walter Emmott, consulting electrical engineer, has been carrying out a series of experiments in the application of electric arc lighting for interior illumination, more particularly with respect to the most suitable globe for passing and diffusing the light, and at the same time having an attractive appearance. The Tramways Bill promoted by the Corporation will shortly be lodged with the parliamentary officials. The Corporation Tramways Committee have arranged for the plans to show a double line from the bottom of Horton-street to Commercial-street, and single lines to King Cross and Highroad Well. The gauge adopted is 3ft. 6in.

Lancaster.—At the Town Council meeting the Electricity Committee reported that the engineer, acting on the instructions of the chairman, had submitted a report upon the question of the Corporation supplying electric motors, and guaranteeing them to do the work required, and arranging easy terms of payment therefor, with a view to increasing the consumption of electric current during the daytime. Mr. Hall, in moving the confirmation of the minutes, stated that the committee were anxious to encourage the use of electric motors, and would be glad to give any information to those requiring motive power both as to cost and efficiency of electric motors. Mr. Heald seconded, and the minutes were agreed to.

Hampstead.—At the meeting of the Vestry the Finance Committee reported that they had carefully considered the letter of Mr. J. Thwaites, jun., agent for the Norwich Union Fire Insurance Office, stating that certain of the rates for the building and contents of the electric lighting station would be increased from 5s. to 10s. 6d. per cent.; that they found that the increased rates were decided upon by the Fire Offices Committee, and were therefore the same as those quoted by other offices; that there was apparently nothing unusual in the short notice given of the increase; that insurances could be effected direct with the head offices of the companies without the intervention of agents, and that, whether ensured direct or through agents, the rates would be the same. The report was adopted.

Windsor.—The Windsor and Eton Electrical Installation Company is making satisfactory progress with the new works in Peascod-street. The chimney shaft has reached to a height of 60ft., and the boiler-house is almost ready for the reception of the boilers. The work of laying the cables is being rapidly proceeded with. The main is being laid direct in the earth with earthenware pipes alongside for the purpose of laying additional wires when needed. In Eton the mains will extend to the Eton Wick-road and Common-lane. A considerable number of houses and business establishments are being wired, about 50 in number, and including the Eton Supply Stores and Burge and Co.'s Victoria Brewery. The work of laying the mains is being superintended by Mr. Schiasse, engineer to Messrs. Callender.

Walsall.—In the course of an address upon "The Last Six Years' Work of the Town Council," Councillor Walter Hughes said that the consent of the Corporation for the adoption of the electric overhead system for trams was justified by the results, and he hoped the question of the electric tramways in the borough would end in Walsall either acquiring them or having some control, an important matter which was now under consideration. The electric generating station had now replaced the old gasworks, and the electric lighting scheme had cost £19,000, this being a necessary outlay in view of keeping out of the town competitors who would have been only too glad to have secured the electric light monopoly, and so, perhaps, jeopardise the hitherto prosperous gas undertaking.

Long Eaton.—A letter was read at the District Council meeting from the District Councillors' Association, stating that Long Eaton did not seem to be included in the list of places having obtained orders for electric lighting powers. He (the clerk) did not know it was necessary to take action now. Mr. Winfield was afraid they had committed themselves—or, rather, the old Local Board did so. He believed the power was given to a private company. The Clerk said he would look up and see if anything had been put on the minutes. Mr. Widfield said he had a conversation the other day with Mr. Whiteley, who was of opinion that they had compromised their position. Mr. Orchard and Mr. Marriott both thought the Board simply decided no action be taken. The matter will be looked into.

Lighting Improvements in London.—The repaving of Piccadilly and Piccadilly-circus has now been completed, and in a short time the electric light will be installed. The scheme adopted by the St. James's Vestry includes the whole of Regent-street, Piccadilly-circus, Piccadilly (as far as St. James's street, where the parish of St. George's begins), St. James's-street from Park-place, Pall-mall, Lower Regent-street, and Waterloo-place, Coventry-street, and Shaftesbury-avenue as far as Wardour-street. The columns, 18ft. high, will be placed on the refuges in the middle of the street, and will be fitted with 10-ampere Crompton-Pochin lamps. There will probably be seven or eight lamps in Piccadilly-circus. Current will be supplied by the St. James and Pall Mall Company. Oxford-street and Marylebone will be added to the scheme later on.

Bray.—A public meeting of the ratepayers has been held for the purpose of considering whether the proposed promenade pier and electric tram schemes would be beneficial to the township. The Chairman stated that they had got a consensus of opinion from the frontagers where the trams were proposed to be run, whose total valuation amounted to £11,296. They had got a memorial in favour of the schemes from ratepayers representing a valuation of £4,500, and a memorial against them from ratepayers

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representing a valuation of £651. A resolution was passed asking the Town Commissioners to sanction the schemes, which, if carried out, will mean an expenditure of about £35,000 in the town. As a result of the interview of the deputation with the Commissioners that body have decided to ask Mr. Molloy to supply them with all plans in reference to both schemes.

Edinburgh.—At the Town Council meeting notice of motion was given by Messrs. Scott and Mallinson to remit to the Cleaning and Lighting Committee to consider and report as to the electric lighting of Haymarket-terrace as far west as Magdala-crescent. Both Mr. Cranston (convener of the committee named) and Treasurer M'Crae protested against bringing up a question like the further extension of the electric light in the middle of the financial year. The estimates were all framed, and this insidious method of procedure would have a disturbing effect upon them. The Lord Provost said they had a sort of understanding that they should endeavour to introduce the electric light wherever there were tramways. Ultimately, however, the motion was withdrawn on the understanding that a scheme for extension would be brought up at the beginning of the next financial year.

Glasgow.—The *Glasgow Herald* publishes the following: "We are hearing a great deal in these days of German competition and of the need for the people of this country being alive to the growing enterprise of the sons of the Fatherland. The following example of that 'enterprise' could hardly be excelled. It is the text of a postcard forwarded by a Hamburg firm of dynamo and motor manufacturers to merchants in this city with whom they never had business associations: 'Sir,—I shall esteem it a great favour if you will kindly oblige by letting me know whether you use dynamos or motors, either for producing electric light or for generating power, and whose make the machines are. At the same time I should thank you to give me, on the annexed card, the names of those firms and individuals in your neighbourhood possessing either dynamos or motors. It will afford me pleasure to reciprocate your kindness when an opportunity occurs. Thanking you in anticipation of a reply.—I am, etc.'"

Rotherhithe.—At the meeting of the Vestry a letter was received from Mr. S. Morse, on behalf of the County of London and Brush Provincial Electric Lighting Company, Limited, asking for the formal consent of the Vestry to the application of the company for a provisional order to supply electrical energy to the parish of Rotherhithe. The compulsory streets scheduled are Union-road, Albion-street, and Rotherhithe street. Mr. Stokes (the clerk) pointed out that the Vestry gave their sanction eight years ago to the granting of a provisional order to the London Electric Supply Corporation, who were supposed to carry out their works within two years from that date. They had, however, only laid mains in Rotherhithe New-road. The matter was referred to committee, and the clerk was instructed to write to the company who already possess powers to supply electricity within the parish asking whether they intended to proceed with their order, and pointing out that they were liable to penalties for the delay.

Kingswood.—A meeting of the Lighting Committee of Kingswood Urban Council has been held to consider whether the plant, etc., used for the electric lighting of the district should be purchased. The sum first asked by Messrs. Parfitt was £3,500, but this was subsequently reduced to £3.200. The present agreement with the electricians for supplying the light is optional for seven, 14, or 21 years, and as yet less than one-third of the time limit has expired. In the event of the installation being acquired by the Council it would be requisite to have a loan covering a period of 20 years. Mr. Parfitt explained that the purchase would not cost the ratepayers very much more than at present if a loan was acquired. A discussion followed, in which the lighting of the district by gas was incidentally referred to. The question of having the plant valued by an expert electrician was also mooted. Finally, it was resolved to recommend that an expert be requisitioned to value the plant with a view to purchase or otherwise.

Bermondsey.—The Electric Lighting Committee of the Vestry recommended at the last meeting that Messrs. Kincaid, Waller, and Manville be engaged, at a fee of 50 guineas, to report upon the following points—namely, (1) whether the supply of electricity could be advantageously undertaken by the Vestry, and at what preliminary loss; (2) what would be the best system of supply for the Vestry to adopt, and the best site for a generating station, and the capital required; (3) as to the advisability of combining a dust destructor with the station for the utilisation of heat; and (4) generally on the best means of putting the scheme into operation. This was agreed to, and it was referred to committee to appoint a deputation to wait upon the Board of Trade with a view to ascertaining whether there was any probability of the Vestry obtaining a provisional order should they decide to undertake the supply of electrical energy to the parish. The firm of electrical experts will not be engaged unless a favourable reply is received from the Board of Trade.

Liverpool.—A section of the members of the Liverpool Engineering Society paid a visit last week to the exchange of the National Telephone Company in Exchange-buildings. The gathering was a numerous one, the gentlemen being met by the district manager, Mr. Arthur Martin. Small groups were conducted by Mr. Martin and his assistants over the extensive premises comprising the telephone exchange, and had explained to them the process of "ringing-up" and switching on of subscribers. Besides the switch-rooms, the battery and test rooms were also inspected. Before separating, Mr. Martin was very cordially thanked, on the proposition of the president (Mr. A J. Magginnis), for the courtesy he had extended to the society's members. The City Council have decided to promote a Bill in Parliament to acquire the undertakings of the Liverpool Tramway Company. It is stated that the amount required would be from three-quarters of a million to a million. The Council propose to substitute some form of mechanical traction for the present system of horses.

Birmingham.—After holding 11 meetings and fully considering the whole question of tramway municipalisation, the Public Works Committee of the Corporation have come to the following conclusions, which have been ratified by the Council: "(1) That the committee have not sufficient experience of the working of tramways by municipalities to guide them as to the probability of the Corporation desiring to take the tramways into their own hands at the expiration of the existing leases; (2) that the experiments being made in methods of traction, autocars, etc., render it desirable that for the present the tramways should continue to be worked by lessees, under such covenants for ensuring cheap and quick transit, and safety, comfort, and convenience of the public as may be thought necessary; (3) that the Corporation would not be justified in rejecting the immediate and prospective advantages which they and the public would derive from the acceptance of the offer (that of a syndicate which offered a rent of £185 per mile per annum for renewal and extension of lease—the estimated clear rental being £5,000 a year).

Cambridge.—The Paving, Drainage, and Lighting Committee reported at the Town Council meeting that of late when it had become necessary for the Cambridge Electric Supply Company, Limited, to break up any of the streets or parts of streets for the purposes of the Cambridge Electric Lighting Order, 1890, the company had carried out the work through its own workmen, instead as formerly, when any repairs or alterations became necessary, of calling on the Corporation to do the work and paying the necessary costs incurred. The committee were of opinion that, as the Corporation were responsible for the repair of the streets, it was inconvenient and undesirable that the company should have power to interfere with them, and recommended that notice be given in accordance with Section 12 of the order to the effect that the Corporation desire to exercise or discharge all the powers and duties of the undertakers in relation to the breaking up, filling in, reinstating, or making good any streets, bridges, sewers, drains, tunnels, or other works vested in or under the control or management of the Corporation. The report was adopted.

Motorcars.—In view of the presence in Liverpool of Sir David Salomons, Bart., president of the Self-Propelled Traffic Association, the vice-president of the Liverpool centre of that association (Mr. A. L Jones) gave a luncheon this week to Sir David and some 40 gentlemen prominent in Liverpool commercial and engineering circles. In proposing the health of Sir David Salomons, Mr. Jones spoke in pointed terms of the future which he anticipated for motorcars for the conveyance of cargo from the ship's side to warehouses, whether in Liverpool, Manchester, or other portions of Lancashire. In connection with motorcars it was proposed to form a company—the Liverpool and Lancashire Road Carrying Company—which would make use of existing highways, and by means of which the cost of carrying cargo to places within 40 miles would not exceed 3s. 6d. a ton, whilst the delays of going into stations and of unnecessary handling of goods would be done away with. The conveyance of goods would thus be done at one-third of the present railway charge—a tremendous advantage to traders. Sir David Salomons responded, and other speeches were made.

Vestries and Electric Light.—At the Newington Reform Club, Walworth, last week, an address was delivered by Mr. Alderman N. W. Hubbard, L.C.C., upon "Should vestries provide electric light for their respective districts?" In the course of an exhaustive address the lecturer referred to many municipalities which had introduced electric light at the cost of the local rates and maintained such installation with profitable results. Many provincial towns were far ahead of London in several matters, and more particularly in electric lighting, and this was due to the fact that those governing authorities were not afraid of spending money which they felt would prove a benefit to the ratepayers. If provincial towns could make a success of such an undertaking, why could not the Vestry of Newington and other vestries of London? He did not believe there was a parish in London which could not adopt the electric light system with advantage to the ratepayers. He hoped the people of Newington would put their shoulders to the wheel and make a success of the electric light, for then in future years their children would be thankful to them for having fought their battle.

Huddersfield.—At the meeting of the Town Council the Central Wards Committee recommended the adoption of a scheme for the lighting of the streets in a certain area of the central wards by electricity instead of gas. It was stated that the present cost of lighting the area was £806. 14s., and that the new scheme would effect a saving of £130. 13s. In the course of discussion frequent complaints were made of the present inefficient lighting of the streets by gas, and several members of the Central Wards Committee said that the alteration was being made as much on the ground of efficiency as of economy. The recommendation was approved by a large majority, over an amendment moved by Alderman Stocks, the chairman of the Gas Committee. Alderman Calvert, chairman of the Electric Lighting Committee, whilst denying that the electric lighting department had been subsidised by £6,000 since its establishment three years ago, said that the actual subsidy was not greater than would have to be paid at the commencement of any such undertaking. The electric lighting department had had a satisfactory year; and it was confidently hoped that there would be a balance in hand at the end of the present

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financial year. Aldermen Joseph Brooke and Stocks and Mr. B. Broadbent were appointed as a sub-committee to act in conjunction with representatives of the local technical instruction institutions to formulate a uniform scheme of technical instruction in the town.

Manchester.—A syndicate composed of Manchester men has been formed to further a scheme for the establishment of a new Mutual Telephone Company, Limited. In a circular which has been issued it is stated that "for some time past the service in this city has been exceedingly unsatisfactory, and there is a widespread discontent amongst the subscribers to the telephone, both on this ground and also because the charges in connection therewith are considered to be excessive. With a view of remedying these evils, a number of gentlemen have formed a syndicate to float a new telephone company, which will offer to subscribers the benefit of an improved system at reduced rates. The gentlemen forming the syndicate feel, however, that it would be useless to incur the expense of floating this company unless they can rely upon the support both of the present users of the telephone and those intending to use it in the future." The object of this circular is to ascertain the extent to which the required support will be given. The Corporation have decided to put up arc lamps in Albert-square, St. Ann's-square, and Piccadilly, and the charge for the current is to be 2d. per unit. They have also resolved to insert a clause or clauses in the omnibus Bill about to be applied for by the Corporation to enable them to supply electricity beyond the limits of the city by agreement with adjoining local authorities, and further to extend the powers of the Corporation in reference to the supply of electricity. The Gas Committee having reason to believe that several local authorities are willing to make arrangements with the Corporation to supply them with electricity in their districts, they have been authorised to make suitable arrangements with them.

Tunbridge Wells.—The *Tunbridge Wells Courier* publishes the following statement: "Electric lighting.—An experiment has been tried this week of placing two 8 c.p. incandescent electric lamps in an ordinary gas lamp, with the addition of a reflector, which is the clever invention of the borough electrical engineer (Mr. H. P. Boot), and has just been patented by him. One of the darkest thoroughfares in the town—London road—was selected for the trial, which is remarkably successful, and should lead to the extension of the system in all thoroughfares where arc lamps are not used. The light, thanks to the ingenious arrangement of the reflectors at varying angles, gives about six times the illumination of a gas lamp, and the committee will be able to supply them at the same annual cost as the gas lamps. The lamp, which is just below the Castle Hotel is well worth inspection. A number of new customers are still recorded. This week the Kent Drug Stores, which recently put in incandescent gas, have now substituted the electric light; and the articles of virtu in Mrs. Smither's old curiosity shop have been simply transformed under the new illuminant. The revenue earned at the central station has lately been as much as £25 per day. A good deal of attention has been attracted to the incandescent gas 'arc' lamp outside Mr. Pelton's, over which an electric arc lamp has been placed from the office and showroom of the Electrical and General Engineering Company. This affords an excellent test of the two illuminants, and the 2,000-c.p. electric lamp practically extinguishes the 160 c.p. of the triple incandescent burner, although we are assured on good authority that the cost of the two lamps is practically equal, but the illuminant of the arc lamp is infinitely superior."

Leyton.—At a special meeting of the Urban District Council Prof. Robinson (electrical engineer to the Council) reported that owing to the rapidity with which the householders had connected up and the number of applications that had been received it was necessary for the Council to at once extend the plant at the central station, otherwise it would be impossible to supply the current, and much profitable business would be lost this winter. He recommended the Council to put down another gas producer, and two more engines and dynamos, for which space was provided in the existing buildings. He also advised an extra set of batteries with a battery-room to contain them. The total cost of this work would be rather more than £3,000, and it would provide them with 2½ times as much power as they had available at the present moment. He had been making arrangements for supplying the light to the Temple Mills goods-yard of the Great Eastern Railway Company, which alone would absorb a great part of the output from the additional plant. The Highways and Lighting Committee recommended that these additions be made and be treated as an extra to the current contracts. Mr. Trumble moved as an amendment that the recommendation be referred back. Rumours he said, had got abroad that the electric light cost 200 per cent. more than gas. Captain Macey and Mr. Pittam said it was ridiculous to think of more plant before they had a lamp in the street. The latter said they were spending or had spent £21,000 in putting up works and in lighting only four miles of their roads Mr. Bishop stated that the number of lights used by private consumers was approximately 300 16 c.p., and 100 more 16 c.p. had been applied for. Mr. Trumble ultimately withdrew his amendment, and the report was adopted with only two dissentients.

Cardiff.—At the Borough Council meeting Councillor Waring proposed that permission be granted to a Queen-street draper to fix three arc light standards on the kerb in front of his shop, subject to his entering into an agreement that the lamps should be kept lit every evening from the time the public street lamps were lighted until the closing of his business. This was seconded, and in the course of some discussion considerable objection was taken to the proposal on the ground that the street, which is well enough lighted, would be obstructed at that part by putting more lamps there. The motion was ultimately rejected by 13 to 10 votes. Councillor Morgan Morgan, in the absence through illness of Alderman Carey, moved that a resolution passed last year appointing Mr. Neville Applebee to take charge of the lighting station under the supervision of the borough engineer at a salary of £200 be rescinded, and "that Mr. Applebee be appointed electrical engineer at a salary of £200, to take entire charge and control of the electric light undertaking, and of the apparatus, plant, and other property in connection therewith, and also the staff, and that he be directly responsible to the Lighting and Electrical Committee for the due performance of all duties appertaining to his position or in relation thereto; the appointment to be determined by one month's notice on either side;" the question of salary to be paid in connection with the above post to be reconsidered at a future date. He pointed out that the borough engineer was himself desirous of being relieved of the responsibility owing to the great amount of other work he had to do. Councillor Munn seconded. Councillor Jacobs remarked that the relations existing between Mr. Applebee and the borough engineer were of the most amicable character. The resolution was adopted, and the minutes of the Electrical and Lighting Committee were also passed.

Lighting a Yacht by Electricity.—In the City of London Court on October 28, before Mr. Commissioner Kerr, an action was brought by Froggatts Electric Lighting Company, Limited, Lorrimore-street, Walworth, to recover the sum of £32. 13s. 8d., the balance of £115 against Mr. Cecil Quentin, a retired engineer, 23, St. Swithins-lane, E.C., for work done and materials supplied in equipping the defendant's yacht with electricity. Mr. Mallinson appeared for the plaintiff and Mr. Kerby for the defendant. The plaintiffs' case was that the defendant instructed them to fit up his yacht with electric light. The vessel was lying at Burnham Crouch. The plaintiffs did the work, and after some trouble they received a cheque for £50 on account, but the defendant would not pay the balance. Mr. Kerby said that the plaintiffs were not suing for the whole amount of the original price agreed upon. The reason the defendant would not pay the amount now claimed was because he said that the accumulators were no good, and that instead of lasting for 80 to 100 hours, as the plaintiffs said they would do, they went out after burning for only about five hours. The £50 was paid on the express condition that the plaintiffs would make the accumulators work properly, which they had never done yet. Mr. Mallinson said the accumulators were ready for the defendant. They were in thorough working order. They told the defendant that it would be necessary to renew the accumulators three or four times before they could be relied upon. The defendant said that he went on a cruise to France and Belgium, and the lights went out soon after he had started. Mr. Commissioner Kerr said he thought the defendant had behaved very liberally in the matter. The lights did not work properly, and all the defendant had asked the plaintiffs to do was to put them right. That they had never done. The consideration for which the defendant had paid his £50 having failed, there must be judgment for the defendant, who might bring an action for damages against the plaintiffs if he was so inclined.

Southport.—A meeting has been held, under the presidency of Mr. J. H. Wilkinson, of London, to take steps to form a company to carry out the scheme for an electric tramway between Southport and Blackpool, embracing Lytham and St. Annes. Plans have been prepared by Mr. Stewart Speedy, architect, of Southport, and he estimates the requisite capital at £400,000. The tramway, if constructed, will commence near the end of the north lake on the Southport foreshore, where an entertainment pavilion will be erected, and will include a carriageway and pathway for pedestrians. The structure will cross the mouth of the Ribble in its course to Lytham, but by the provision at this point of a swing-bridge Mr. Speedy has got rid of all danger of interference with shipping. Liverpool passengers by taking this route to Blackpool would cut off no less than 26 miles from the journey, while the saving between Southport and Blackpool would be something like 30 miles. It is also proposed to erect in connection with the scheme pavilions for various entertainments at Lytham and Blackpool The Chairman said that for over 20 years that scheme had, in one phase or other, been under consideration, but to Mr. Speedy was due the credit of having formulated a scheme upon business lines. He had no hesitation in saying that any scheme formed on such lines was sure of financial support. Southport and Blackpool were the favourite holiday resorts of Lancashire people, and the bringing of these two places into closer association was a question which had been much thought of. He though that if the proposal were carried into effect it would induce a large number of people who visited Blackpool to come to Southport, and *vice versâ*, and the natural result would be that the tradespeople of both places would be benefited. As they were doubtless aware, something like £450,000 was required, but all financial people would know that it was easier to raise half a million upon a properly organised scheme than £10,000 upon a scheme which had no basis and no solidity. He thought they would have no difficulty in the raising of the capital if they were able to show people with money that the scheme had a revenue-producing power, irrespective of capital value. It was decided to form a provisional committee, with Mr. W. King as secretary, to take the necessary steps for the formation of an influential committee, and to hold a further meeting this week.

New Company.—Messrs. B. Verity and Sons, of London, Birmingham, and Manchester, have converted their firm into a private limited company, under the title of "Veritys Limited." This has been done in order to cope with the increase of their business, with a view of interesting certain of their managers in

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the active working of their businesses. No shares in the new company will be offered to the public, and the management will continue in the same hands. The chief feature in the new concern will be the inclusion among the directors of three of the more prominent employés of the old firm. Ultimately others engaged by the company will have opportunities of becoming financially interested. The firm was established in the early part of the century by Mr. B. Verity, the grandfather of the present owners and, although some of the earlier ledgers and books were destroyed in 1851, wages books and ledgers dating from 1837 are still in existence. In these many accounts with leading English families can be traced through three and four generations In the early days many small gasworks and gasmaking apparatus were erected by the firm, who also, it may be mentioned, fitted gas-pipes throughout Blenheim Palace in the fifties. It is noteworthy that the firm has thus taken a prominent part in the development of both gas and electric light. On the death of the founder in 1861 the business was partially divided, and the firm of Messrs. Verity Bros. started by two of his sons. This business was, however, again absorbed by Mr. John Verity on their deaths, and Veritys Limited thus take over these two old-established businesses with the more recently founded businesses of Veritys carried on by the firm in Birmingham and Manchester. The number of employés of the firm when taken over by the company was 644, but in view of the large new works now being erected at Aston this number will soon be very largely added to. The new works, which will provide accommodation for from 700 to 800 men, are to be employed chiefly in the manufacture of accessories, such as switches, fuses, lampholders, switchboards, etc., but some new departures will also be made. Thus it is proposed to manufacture small motors on a large scale, and at a price to successfully compete with the foreigners. It is pleasing to note that in artistic fittings we export into Germany. Thus Messrs. Veritys Limited have now in hand a large order for fittings from the noted firm of Krupp, and we have heard of large export orders from other firms. We wish the newly-constructed firm every success.

Tonbridge.—A special meeting of the Urban District Council has been held for the purpose of receiving a report from Mr. B. Hastings Medhurst, electrical engineer, on a scheme for the supply of the electric light. The clerk stated that a meeting of the Electric Lighting Committee took place that afternoon, when the report from Mr. Medhurst was read, and he (Mr. Neve) had since prepared the following summary and abstract of Mr. Medhurst's report: Estimate: that at least 2,000 lamps of 16 c.p. in use at expiration of first completed year's working. Site recommended: the garden in rear of 83, High-street. Compulsory area: from bottom of Brook-street, Quarry Hill-road, Station Bridge, High-street, and Dry Hill Park. Optional area: the whole of the district. System to be adopted: the three-wire low-tension. Capital expenditure: for 2,000 lamps, inclusive of buildings, machinery, mains, etc., between £10,200 and £10,400—say, £10,300. Revenue: the estimated income from 200 lamps at 6d. per unit would produce about £1,800 a year. Working expenses: not more than £1,100 per annum. To this must be added a sum of £566. 10s. for repayment of loans. Public lighting: The street gas lamps in the compulsory area to be replaced with incandescent electric lamps of various candle-powers The capital outlay to secure this will be £700. Present annual cost of of gas lighting in this area is £193 5s. 3d. The increased working expenses rendered necessary by street-lighting, including lamp renewals, attendances, extra coal, etc., would not be more than £100, and the additional loan would necessitate repayment of £38. 10s. a year. This would show a profit of over £50 per annum, and the lighting itself would be about twice as good as at present. Motive power: much of the plant at the sewage works is antiquated, and some is so old and worn out as to be almost useless. The present yearly working expenses at the sewage works are £417. 18s. 4d., including wages, coal, gas, repairs, and sundries. If the present steam-engine and gas engines were removed and replaced by electric motors, a supply of current could be obtained from the central station, and an estimated saving of at least £200 per annum in working expenses would be secured. Additional capital expenditure about £1,500 necessitating interest and sinking fund about £82 10s., thus showing a saving of £110 per year. Mr Medhurst strongly advises the Council to apply for a provisional order and to carry out the entire scheme above indicated. Summary of figures: Working expenses, £1,100; repayment of loans, £566; public lighting—working expenses, £100; loans, £39; sewage works loans, £83—£1,888; estimated profit, £305—total, £2,193. Revenue from 2,000 private lights, £1,800; saving in public lighting, £193; saving in labour and sewage works, £200—total, £2,193. Councillor Race, chairman of the Electric Lighting Committee, moved that application be forthwith made to the Board of Trade for a provisional order, and Councillor Jones seconded. In reply to various questions Mr. Medhurst said experience proved that works had been laid down in country towns, which had turned out much too small for the demand which had originally arisen, and the result of this was that local authorities had had to spend more money at the end of five or six years than they would have done if a more reasonable estimate had been made in the first instance of the demand which would accrue. Thus the reason that he had estimated for at least 2,000 lamps in use at the expiration of the first completed year's working. He proposed to use steam power, for it was preferable to gas. Gas-engines did not run with that steadiness which was required for electric lighting purposes. It would be best to use accumulators for such a town as Tonbridge, and they would be able to work with two shifts instead of three.

Swansea.—At the meeting of the Corporation, the Tramways and Electric Lighting Committee reported the terms of the agreement scheduled to the Bill to enable the Corporation to acquire the tramways undertaking were discussed. Mr. Kincaid informed the committee of the readiness of the directors of the tramways company to now meet the requirements of the Corporation, and it was arranged that a new agreement should be drafted accordingly for the approval of the Corporation and the company, upon the same terms as that set forth in the schedule to the Bill intended to be promoted in the last session of Parliament. The town clerk submitted the draft agreement relative to the purchase of the tramways undertaking, and suggested to the committee certain alterations therein, and it is recommended that the settlement of the agreement upon the terms indicated be referred to the chairman and the town clerk. Mr. Ruck and Mr. Kincaid attended, and certain of the provisions of the proposed agreement with the company for the purchase by the Corporation of the tramways undertaking were discussed, and it was agreed that the amount (if any) to be paid on account of the redemption of debentures should be a capital charge on the sum of £2,000 intended to be provided by the Corporation. The committee approve of the terms of the agreement, and recommend that a Bill be promoted in the next session of Parliament to empower the Corporation to acquire the tramways undertaking upon the terms contained in such agreement. Mr. Richard Martin moved the minutes of the Tramways and Electric Lighting Committee. It would be in the recollection of the Council, he said, that this subject was last before them on February 14 last, when the minutes of February 10 were confirmed. There was a letter received that morning from the solicitors of the company which admitted of differences of interpretation. The Council gave the tramway company an opportunity of saying "aye" or "nay" to those minutes, but the only reply they had was a letter from the solicitor, that he could not add to the letter of February 13. Then the matter dropped. On April 3 the town clerk received a letter from the engineer of the company, stating that he was strongly of opinion that the negotiations fell through rather from misunderstanding than on account of any serious points of difference. That letter pointed out the start of the renewal of the negotiations. The town clerk saw him (Mr. Martin) about the letter, and he replied to Mr. Kincaid on April 9: "I shall be glad to know whether the directors of the company are now prepared to accept the terms submitted in my letter of February 10 last, and if so will they call a meeting of the shareholders to confirm their action. I may at once say that nothing short of this would justify the Corporation in reopening the negotiations." There was another letter that passed between them on April 22 from Mr. Kincaid, who wrote: "I have a letter from the directors authorising me to conclude the agreement." That was the point they came to when they called the committee together on May 18 to meet Mr. Kincaid. The result of that meeting was the drawing up of a draft agreement upon the terms as submitted by the committee on February 10 and as confirmed on February 14. There was a meeting held on July 7 to consider the amended draft sent back by Mr. Kincaid, and on October 6 there was a meeting held to allow the directors of the tramway company to appeal to the Corporation to make some alteration in the Bill. The meeting spoke for itself as to the result. The great point of difference that occurred between the Corporation and the company, when the negotiations collapsed, was the spending of the £32,000. That was the point to which he personally attached most importance. With the Mayor and town clerk they felt that the Corporation ought to have absolute control over that money, that it should not be possible for the company to take it away and spend it in any shape or form, but upon what was agreed between the Corporation and the committee. That, the Council would see, had been secured. The agreement itself mentioned the purposes of the spending of the £32,000. Every penny of the money was to be spent directly or indirectly in the matter of the equipping of the tramways for use. The other points that they were not at all agreed on were now included in the present agreement. The Corporation on February 13 submitted that they were prepared to allow the money required for widening streets to be repaid on a 30 years' basis; also that the cost of the Bill be on the same terms. The Corporation further offered to pay for the accumulators if the company paid for the transformers. The company now agreed to pay for the transformers. The Corporation now agreed to take over at the end of the term all the rolling-stock of the company on the basis of a valuation. Those points were all contained in the present draft of the agreement, and he (Mr. Martin) knew of nothing that the Corporation demanded from the company in February that was not contained in the present agreement. Mr. R. S. Lindley seconded. An amendment was proposed to refer the minutes back to the General Purposes Committee for full discussion, but after some discussion the amendment was lost by 11 votes to 16, and the minutes were adopted. The tenders for the electric lighting of the market have been forwarded to Messrs. Kincaid, Waller, and Manville for examination and report.

PROVISIONAL PATENTS, 1896.

October 19.

23178. Apparatus for varying the speed of electromotors. Charles Denton Abel, 28, Southampton-buildings, Chancery-lane, London. (Berliner Maschinenbau-Actien Gesellschaft vormals L. Schwartz Kopff, Germany.)

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23127. Improvements in or in connection with arc lamps. Frank Michael Lewis, 30, Park-row, Leeds. (Complete specification.)

23161. Improved electric lamp advertisement attachment. Edward Augustus Ingold, 66, Wandsworth Bridge-road, Walham Green, London.

23189. Improvements in or connected with means or apparatus for producing light by electricity. Charles Henry Stearn, 47, Lincoln's-inn-fields, London.

23194. Improvements in nitrated fabrics for electrical and other purposes. Carl Hoepfner 45, Southampton buildings Chancery lane, London.

23195. Improvements in machines for weaving insulating coverings on electrical conductors. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London (Augustus T. Clark, United States.) (Complete specification.)

OCTOBER 20.

23242. Improvements in and relating to electric incandescence lamps. Forest William Dunlap and John Robert Quain, 60, Queen Victoria-street, London.

23249. An improved insulator. James Houghton Cottingham, 91, Sharkhouse, Crawlington, Northumberland.

23256. Improvements in electric lighting for velocipedes, cabs, broughams, omnibuses, tramcars, or any other vehicle, and in the method of generating and storing electrical energy therefor by the utilisation of the motive power of the said velocipedes, cabs, broughams, omnibuses, tramcars, or any other vehicle. Albert Montague Armstrong, 59, Derby-road, Croydon

23258. Improvements in primary electric batteries. John Edward Preston and Cuthbert Simkin, 7, Southampton-row, London.

23282. An improved method of and arrangements for illumination by means of incandescent electric lamps. Pierre Charles Eugène Champion, 45, Southampton-buildings, Chancery lane, London.

23291. Improvements in or relating to trolleys for overhead systems of electric traction. The British Thomson-Houston Company, Limited, 70, Chancery-lane, London. (Norman C. Bassett, United States.) (Complete specification.)

23315. Improvements in electrical apparatus for controlling traffic on single lines of railways. John Patrick O'Donnell, 70, Palace-chambers, Westminster, London. (John Wells Wainwright Hopkins, Argentine Republic.) (Complete specification.)

OCTOBER 21.

23335. Displaying prices and the like in shop windows and other places by electric illumination. John Richardson Craig, jun., 115, St. Vincent-street, Glasgow.

23339. Phil Phillips's electric mat and cushion. Phil Phillips, 24, St. Mary street, Cardiff.

23352. Improvements in electric sparking apparatus for ignition purposes in oil and gas motors and the like. Edward William Lancaster, Church-road, Moseley, Worcestershire.

23393. Improved portable telephone apparatus. Joseph Kandt, 322, High Holborn, London. (The firm of Töpffer and Schädel, Germany.) (Complete specification.)

23399. Improvements in electric switches. Hans Friedrich Kleinschmidt, 45, Southampton-buildings, Chancery-lane, London.

OCTOBER 22.

23474. A new or improved method of and apparatus for electrically lighting cycles and other vehicles. Henry Torkington, 76, Chancery lane, London.

23497. Improvements in means or appliances for facilitating the drawing of electric conductors through tubes or conduits. Henry Edmunds, 47, Lincoln's-inn-fields, London.

23512. Improvements in electricity meters for alternating currents George Hookham, 18, Southampton-buildings, Chancery-lane, London.

23519. Improvements in bonds for electrical railways. John Henry Beardsmore, Hucknall Torkard, near Nottingham. (Frederick T. Newbury, United States.)

OCTOBER 23.

23531. A combined reflector and fastener for electric lamps. Frederick Williams Allen, 17, St. Ann's-square, Manchester.

23545. Apparatus for controlling incandescence electric lamps when connected in series. John Dugdill, Firs House, Failsworth, near Manchester.

23556. An improved electrical wire joint or connection. John Bremridge Melhuish, 77, Colmore row, Birmingham.

23587. An improved electric alternating-current machine Johan Josef Andreas Minder and Simon Apfel, 6, Lord-street, Liverpool.

OCTOBER 24.

23765. An improved form of contact blades for switches for electrical purposes. Frederick William Heaton and Harry Smith, Salford Switch Works, Sidney-street, Salford, Manchester.

23663. New and useful improvements in the apparatus for the production of oxygen and hydrogen by electrolysis (system Garuti). Pompeo Garuti and Ricardo Pompili, 77, Colmore row, Birmingham. (Complete specification.)

23665. Improvement in telephone transmitter. William Andrew Moore, 52, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883 Sec. 103, March 25, 1896, being date of application in United States) (Complete specification)

23698. Improvements in and relating to electrical governors Percy Wilbraham Northey, 124, Chancery-lane, London.

23766. Improved high-insulation tumbler switch. Frederick William Heaton and Harry Smith, Salford Switch Works, Sidney street, Salford, Manchester.

SPECIFICATIONS PUBLISHED.

1895.

18698. Electric railways or electric transport. Lorrain. (Esmond.)

18699. Electric railways or electric transport. Lorrain. (Esmond.)

18868. Electric velocipedes. Libbey.

19973. Electric arc lamps. Davy.

21367. Electrical indicating and recording meters. Wood and Mayes.

21752. System of using electric lights and other means of illumination. Cuthbert.

22939. Electrical sounding apparatus. Griffith.

23653. Electric tram or railway systems Allen and Peard.

24296. Rotary electric transformers. Blackburn and Spence.

24594. Electric lifts. Stevens and Major.

1896.

17818. Dynamo-electric machines. The British Thomson-Houston Company, Limited. (Thompson and Armstrong.)

18628. Incandescence body for electrical glow lamps and process of manufacture of the said body. Bachmann, Vogt, Weiner, Kirchner, and Konig.

18651. Commutator brush-holders for dynamo-electric machines or electric motors. Lake. (Lundell)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	8½-9
Brush Company, Ordinary	3	⅞-1⅛
—— Non. Cum., 6 per cent. Pref.	2	1⅛-1⅜
—— 4½ per cent. Debenture Stock	100	110-113
Central London Railway, Ordinary	10	10-10½
——	2	4⅛-4⅜
Charing Cross and Strand	5	9½-10
Chelsea Electricity Company	5	7¾-8¼
—— 4½ per cent. Debentures	100	114-117
City of London, Ordinary	10	16-17
—— 6 per cent. Cumulative Pref.	10	17-18
—— 5 per cent. Debenture Stock	100	131-135
City and South London Railway, Consolidated Ordinary	100	50-52
—— 4 per cent. Debenture Stock	100	137-139
—— 5 per cent. Pref. Shares	10	14¾-15¼
County of London and Brush Provincial Co., Ordinary	10	8⅞-9⅜
—— 6 per cent. Cum. Pref.	10	13¾-14¼
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
Edison and Swan United Ordinary	3	1¾-2¼
—— 4½ per cent. Debentures	100	103-106
Electric Construction, Limited	2	1¼-1¾
—— 7 per cent. Cumulative Pref.	2	2½-3
Elmore's Copper Depositing	2	¼-¾
Elmore's Wire Company	2	¼-⅝
W. T. Henley's Telegraph Works, Ordinary	10	17½-18½
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	3¾-4¼
—— 7 per cent. Preference	5	8¾-9¼
India Rubber and Gutta Percha Works	10	21½-22½
—— 4½ per cent. Debentures	100	105-108
Kensington and Knightsbridge Ordinary	5	9½-10
—— 6 per cent. Pref.	5	8¼-8¾
Liverpool Electric Supply, Ordinary	5	8-8½
Liverpool Overhead Railway	10	13⅜-13⅝
—— 5 per cent. Pref.	10	17⅛-17⅝
—— 4 per cent. Mortgage Debentures of £100	100	112½-114½
London Electric Supply	5	⅞-1⅛
Metropolitan Electric Supply	10	13-14 xd
—— 4½ per cent. First Mortgage Debenture Stock	100	121-124
National Telephone, Ordinary	5	7¼-7½
—— 6 per cent. Cum. First Pref.	10	17-19
—— 6 per cent. Cum. Second Pref.	10	17-19
—— 5 per cent. Non. Cum. Third Pref.	5	6¾-7
—— 3½ per cent. Deb. Stock	100	106-109
Notting Hill Company	10	11½-12½
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8½-9
—— £4½ shares	4½	7½-7¾
Oriental Telephone and Electric Company	1	¾-⅞
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	103-105
Southampton Electric Company	5	4¾-5¼
St. James's and Pall Mall, Ordinary	5	11½-12½
—— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	39-42
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	—	7¾-8¼
Westminster Electric Supply, Ordinary	5	10½-11½
Yorkshire House-to-House		7½-8

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NOTES.

The Marine Engineers.—The sixth annual dinner of the Bristol Channel centre of the Institute of Marine Engineers took place on Saturday at Cardiff. The chair was occupied by Prof. Elliott, D.Sc., president of the centre.

France and Russia.—In connection with the visit of the Tzar to Paris, the French Society of Civil Engineers and the Imperial Technical Society of Russia and the Russian Institute of Engineers have been exchanging congratulatory letters.

The Heilmann Locomotive. — According to the *Bulletin* of the Société Belge d'Electriciens a six-cylinder type of engine devised by Mr. Mazen, of the Chemin de fer de l'Ouest, is to be tried for the Heilmann locomotive. The object, of course, is to avoid vibration at the high speed used.

Mont Blanc.—An electric railway for passengers is proposed for Mont Blanc. Up to a certain altitude it would be upon an inclined plane, and the ascent would be completed by a vertical shaft of a depth of 2,539 metres, through which powerful electrical lifts would convey the passenger to the observatory on the summit. The question is, would it pay ?

Science at St. Andrews.—The new marine laboratory in connection with the University of St. Andrews, founded through the generosity of Dr. Charles Henry Gatty, of East Grinstead, has been inaugurated by Lord Reay, who remarked in his speech that the great alarm felt for our industries was due to the fact that science had not been sufficiently recognised.

Brussels Lighting.—From *L'Electricien* it appears that the tariff of the municipal electric supply at Brussels is a little under 7d. a unit. There are three generating stations, and the system is a continuous-current three-wire one at 110 volts. Of 285 customers last January, 106 were business houses and 51 private; 34 were hotels, cafés, etc. There are five theatres. There is very little public lighting.

Lord Kelvin.—There was a report that Lord Kelvin was seriously ill, and another that he had come to London to consult a specialist as to his eyesight. We are pleased to find that both these reports are wrong. As a matter of fact, it appears that Lord Kelvin has been suffering for some time past from severe neuralgia in the head, but last Saturday was so much better as to be able to attend at the Royal Society, Burlington House, for an hour.

Motorcarts.—Motorcarts have been putting themselves in evidence in the usual ways during the last week, and the London County Council seems to have changed its mind about them, and to be now afraid of what it has hitherto advocated. Many other people have been showing a similar inability to comprehend that a maximum speed limit has nothing to do with the question of "furious driving." Apart from the latter, there is no limit to the speed of a horse.

The North Pole.—Mr. Warrington Baden-Powell, elder brother of Sir George Baden-Powell, M.P., has a scheme for reaching the North Pole. According to a contemporary, he suggests that a discarded double-bottomed ironclad, "with enough coal and electric power to plough a way through the ice," should be utilised, and that a syndicate should be formed to carry out the project. He is confident that the plan could be successfully carried out; but probably other people will not share his confidence.

Submarine Telegraph Memorial.—At a meeting of the committee last Monday it was decided to put off the memorial of the establishment of submarine telegraphy till 1901, and to establish a memorial to the late Sir John Pender. In connection with the subject, Mr. C. Bright has written to the *Times*, remarking that "it may be of interest to note that the exact date on which the first submarine cable was open to the public for telegraphic despatches was November 13, 1851." The year 1901 will therefore be the "jubilee."

Weather.—The "depression" which the Meteorological Office said last week was to come over Great Britain took a bend to the south and went to Sweden *viâ* France. The result of it is that they have had a bad time in the latter country, and at Lyons, the electric light works being flooded, the city had to revert to gas. There appears to be something seriously wrong in the weather this year all over the northern hemisphere, or else the monsoon would not have broken off short and produced the "diffused want" which the Indian Government objects to have called by the name of famine.

The Preece Cable.—The *Elektrotechnische Zeitung*, which did not greatly like Mr. Preece's endurance tests of incandescent lamps, appears, on the other hand, to think highly of his new cable. The "Preece telegraph cable," it says, "must be looked upon as a noteworthy advance in submarine telegraph work." The Lowestoft-Nordeney cable of 1866 and the Bacton-Borkum cable of 1896 are compared in the course of the article. The mileage is almost the same, but the KR factor is reduced from 198,100 to 126,000, although the capacity is increased in the proportion of 73 to 84.

Institution of Civil Engineers.—The seventy-eighth session of the institution was inaugurated on Tuesday, Mr. J. Wolfe Barry, C.B., F.R.S., the president, being in the chair. Dr. W. Pole, F.R.S., who recently retired from the post of honorary secretary, was elected an honorary member, and the president then delivered to a large audience an inaugural address. He dwelt forcibly upon the necessity for improved scientific and practical training for students of engineering. He thought that the time had arrived for the adoption of some definite test by examination of candidates for the profession; and, speaking as an individual, he saw no proper way of ensuring the desired result except through the instrumentality of the institution, which was the acknowledged head of the engineering profession of Great Britain and of Greater Britain.

Grants for Science Teaching.—The Lord President of the Council has appointed a committee, consisting of the Vice-President of the Committee of Council on Education (chairman); Mrs. Sidgwick, member of the late Royal Commission on Secondary Education; Sir John F. D. Donnelly, K.C.B., secretary of the Science and Art Department; Sir H. Roscoe, F.R.S., member of the late Royal Commission on Secondary Education; Mr. G. L. Ryder, C.B., H.M. Treasury; Prof. R. C. Jebb, M.P., member of the late Royal Commission on Secondary Education; Mr. W. Armstrong, director of the National Gallery, Dublin; Captain W. de W. Abney, C.B., F.R.S., Science and Art Department (secretary), to consider the mode in which the grants in aid to science and art schools are distributed, and to report if it is desirable to make any alteration therein.

Telephones in Guernsey.—A curious state of things appears to have been brought about by the conflict of laws in Guernsey. The islanders want a local telephone, and, having governed themselves since the time their brother Normans conquered the larger island of Britain, do not see why they should not have it. But it appears that, though most Acts of Parliament have no force in Guernsey, the Telegraph Act has, and consequently a public telephone system cannot be established without the consent of the

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English Post Office. On the other hand, that does not in any way prevent the local Legislature from forbidding the Telephone Company erecting lines even when armed with the license of the Post Office, and, as a matter of fact, the local officials have at least once cut down the wires. The whole affair raises high constitutional points which would be important if Guernsey were not so small and France so near.

Asbestos.—Last Saturday the *Financial Times* announced to all and sundry that a "mountain of asbestos" had been discovered in Canada, and the price of the fibre was to come down to £2 per ton. A "commission" has gone to look at the mountain, and a company is to be formed to work it. This produced a letter from Mr. H. W. Bell, managing director to Bell's Asbestos Company, Limited, who said plainly that the affair was an "impudent attempt to extract money from the British public for a valueless property." Messrs. Ashurst, Morris, Crisp, and Co. replied to this, saying: "A party of our clients, accompanied by experts, left for Canada on the 24th ult., to satisfy themselves on the merit of the undertaking," and "we have already sent out to Canada a copy of Mr. Bell's letter, and have directed special attention to the points he raises—which, however, are not likely to have escaped the experts." There have been other letters. When the experts come home we shall know more about it. It does not appear that the outside public are to be asked for any money until this has taken place.

The District Low-Level.—A meeting has been held between the syndicate and the Board of the District Railway in regard to the electric low-level scheme. Mr. Forbes was away ill. It is stated that only one director is opposed to the scheme, and that pressure is being exerted to induce the syndicate to provide a station for the Imperial Institute and Albert Hall. Victoria is surely more important. It is understood that Sir Benjamin Baker, in his report, suggests that the originally proposed capital of £1,000,000 is insufficient, and proposes that a little over £1,400,000 should be provided to include the expenses of sidings and a gradient from Gloucester-road to Earl's Court, Sir Benjamin being of opinion that trains must be run through without passengers having to change. Meanwhile there has been a project started of an electric railway of the City and South London type from Cannon-street to Hammersmith. This is to depend on local traffic, and is apparently laid out to tap as many theatres as possible. If carried out, with the addition of a few subways, it looks a bad prospect for cabs and omnibuses.

Cable Interruptions.—The month's cable interruptions, as given in the list of the *Journal Télégraphique* to October 25, comprise the following in which communication was not reported as restored at that date: Puerto Plata and Martinique, December 19; African Transcontinental, beyond Mazoe, March 11; Amazon Company's cable, May 4; Columbian (New Granada) land lines, July 4; Salisbury and Umtali line, July 11; Parà and Maranham, August 6. There was a repair of this on September 21, but it failed again on October 8. Communication was restored on October 3 over the Ecuadorian land lines (failure August 11), so that in this case South America has beaten South Africa. The Bahia and Rio de Janeiro cable was restored on October 2, after a month's failure. The restoration of communications on the Penang and Medan, the Loanda and Benguela, and the Zanzibar and Mombassa cables belong to the end of September, but could not be reported in time for that month's list. Other short interruptions were on the Florida land lines, and the Siberian, the Saigon and Bangkok, and the Bolindo and Manilla lines.

Electric Lighting in Spain.—A considerable amount of space is devoted by *Electron* (Madrid) to the remarks made recently in the *Electrical Engineer* on the subject of electric lighting business in the Peninsula. On the whole, our Spanish contemporary appears not to disagree greatly with the views expressed, but is apparently not at all pleased with the reference made to the light and flimsy character of the buildings of some of the central stations in the North of Spain considering the valuable machinery they have to protect. After admitting that it has not visited the stations in question, our contemporary says that they are only temporary, and hopes that the writer of the article in the *Electrical Engineer* may live as long as Methuselah, "and then he will see in time central stations projected of a splendour to suit his taste." "For the rest," *Electron* continues, "we recognise willingly that the productions of English industry are excellent, and that it is proverbial in Spain that every English article is of first quality. But many merchants have taken advantage of that belief to sell us as English goods manufactured in some other country." But a suggestion is further thrown out that the Englishman, as a rule, is too dear.

Stoppages.—It is satisfactory to see that electrical fires, in the rare cases in which they do occur, are easily dealt with. On Friday, at the Prince of Wales's Theatre, Coventry-street, Haymarket, during the performance of the second act of "The White Silk Dress," it was noticed that something was wrong with the electric lights, and suddenly those who were behind the scenes on the "prompt" side discovered that flames were running up from behind the switchboard. This board is situated only a few yards from the visible portion of the stage, and it is supposed the wires fused and ignited the wooden casing arrangements behind. The immediate result was that the electric lights all over the theatre became extinguished. There was no panic. The fireman in charge of the fire-extinguishing apparatus at the theatre got one of the private hydrants with which the theatre is fitted into play, and "in a space of time to be measured by seconds the danger was over." With but little delay the piece was proceeded with, the gas, and a considerable portion of the electric lights, being still utilisable. According to one of the daily papers a momentary stoppage in a private installation in the City the other day had a very curious origin. A cat jumped on to the dynamo.

Skinburn by Rontgen Radiations.—A demon strator of the Röntgen rays at the Earl's Court Exhibition has written to *Nature* describing the result of the continued exposure of his hand to the rays. He says the effect is like sunburn, but ever so much worse, so that the skin comes off, and he has even lost some of his nails. The hand used in manipulating the fluorescent screen is, of course, the one affected. There is nothing in the letter, which is a long one, to show whether it is the Röntgen rays proper that produce the result—*i.e.*, those that affect the fluorescent screen or ultra-violet light generated at the same time, unless that gloves did not stop it. It is curious, considering the severity and evidently painful character of the skinburn produced, that nothing in the way of a covering of thin metal foil, or even metallic powder, which would be very nearly opaque to the rays, appears to have been tried. It is just possible that the constant handling of platino-cyanide may also not be good for the finger tips in all cases. It should be clearly understood that it is only very prolonged exposure—for instance, several hours a day for a period of six months—that is considered likely to produce the skinburn. It would be interesting to know how far other operators have experienced anything similar.

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Some Forthcoming Meetings.—The first meeting of the Institution of Electrical Engineers takes place next Thursday, November 12, at the usual time and place. A paper on "Telephone Trunk Lines" will be read by Mr. John Gavey.—The Institution of Civil Engineers meet on Tuesday, November 10, for papers on the Tower Bridge by Mr. G. Crutwell and Mr. Sam. G. Homfray.—The Physical Society meets on Friday, November 13, for papers "On Röntgen Rays," by Prof. Threlfall and Mr. Pollock," and "On the Absorption of Electric Waves along Wires by a Terminal Bridge," by Dr. Barton and Mr. Bryan. The Northern Society of Electrical Engineers meet at Manchester on Tuesday, November 10, for a paper on "Cheap Steam Power" by Mr. John S. Raworth.—The North-East Coast Engineers meet at Sunderland on November 11 for the discussion of various papers.—November 9 is the opening of the winter course of lectures at the Imperial Institute by Prof. Wyndham Dunstan on "The Work of the Scientific and Technical Research Department of the Institute."—The shareholders' meeting of the Western Brazilian Telegraph Company is fixed for Thursday week; and the Motorcar Club meet for Saturday week.—The Institution of Junior Engineers has its inaugural meeting to-night (Friday, November 6), at the Westminster Palace Hotel for the presidential address of Mr. A. R. Binnie, M.I.C.E.

Royal Institution.—A general monthly meeting of the members of the Royal Institution was held on Monday, the 2nd inst., Sir James Crichton-Browne, M.D., LL.D., F.R.S., treasurer and vice-president, presiding. The following were elected members: Mr. George Cawston, Mr. J. Broughton Dugdale, J.P., D.L., Mr. Henry Harben, J.P., and Mr. John H. Usmar. The special thanks of the members were returned to the proprietors of the *Times*, to Dr. Ludwig Mond, F.R.S., Prof. Dewar, and Sir Andrew Noble for their donations to the fund for the promotion of experimental research at low temperatures. At the meeting it was announced that the Christmas lectures to children will this year be given by Prof. Silvanus P. Thompson, F.R.S., his subject being "Visible and Invisible Light"; and it was reported that the managers had elected Prof. Augustus D. Waller, M.D., F.R.S., Fullerian professor of physiology for three years, the appointment to date from January 13, 1897, and also that the managers had appointed Dr. Alexander Scott, M.A., D.Sc., to be superintendent of the Davy Faraday Research Laboratory of the Royal Institution, the directors already appointed by the managers being Lord Rayleigh and Prof. Dewar. After the meeting the members inspected the new rooms which have lately been added to the library of the Royal Institution through the munificence of Dr. Ludwig Mond, F.R.S. These rooms will provide increased accommodation for the members on the occasion of the Friday evening meetings.

Technical Education.—Sir Philip Magnus has been again insisting at Bolton on the need for keeping up with the Germans in the matter of technical education. "What the Germans have done to apply chemical science to industry they are now endeavouring to do in the applications of electricity, and hence their large outlay on electrotechnic laboratories, which they have good reason to believe will prove a productive expenditure. Fifteen years ago there was no teaching of electric technology in any part of Germany to compare with that given in the Cowper-street Schools under the direction of the City and Guilds Institute. And now England has no laboratories as complete nor attended by as many students as those recently erected in Darmstadt. The results of this teaching are shown in the general application of electricity to locomotion to the transmission of power in mills and factories, to illumination, and other purposes." Mr. Bryce has been saying ditto to Sir Philip Magnus at Cripplegate, and adding some nasty remarks of his own on English young men, whom he apparently considers much inferior to Germans or Scotchmen. It is not the young man's fault if, after being taught to admire classics and athletics, he thinks little of the science of which he is left in absolute ignorance. Young Englishmen will work hard enough, especially in competitive work, if they are properly encouraged. The fault rests with older men, like Mr. Bryce, who might have altered things and did not.

Royal Society of Edinburgh.—The last issue of the *Proceedings* of the Royal Society of Edinburgh contains a note on "Centrobaric Shells" by Prof. Tait, which will be interesting to those people who work with electric images. The note points out that with a spherical shell whose surface density is inversely as the cube of the distance from an internal point, its "potential" is the same as if its mass were condensed at the internal point. The proof is similar to the Newtonian proof that a uniform spherical shell exerts no gravitating force on an internal particle. Lord Kelvin's paper on the motion of a heterogeneous liquid resulting from a given motion of its boundary, is interesting from the way in which such familiar matters as cups of tea and half-filled corked bottles are brought to bear on illustrating what at first appear the decidedly paradoxical results of mathematical investigation. In a second paper, Prof. Tait defends Clerk Maxwell's exposition of the kinetic theory of gases from the criticisms of Mr. Bertrand and Prof. Boltzmann. The fact is—though Prof. Tait does not say so—Maxwell has occasionally been superstitiously followed rather than thoroughly understood. Not all men could draw the bow of Ulysses, and Maxwell, were he alive, would probably be the first to repudiate the rigour with which it is now customary to push the results of his theory. More directly connected with electrical matters is Dr. Beattie's investigations in the relation of the Hall effect and thermo-electricity in bismuth and various alloys. The subject has been referred to before, and definite conclusions on the matter have by no means yet been attained. From a note of Dr. Macintyre's it would appear that amateurs in making cryptoscope screens for Röntgen ray work are liable to put the fluorescent salt on too thinly.

Low-Temperature Work.—It has perhaps appeared rather a puzzle to some why oxygen and nitrogen, although possessing different boiling points, come down at almost exactly the same temperature when air is cooled, and therefore are not separated in the process of liquefaction. Prof. J. Dewar explained this, as well as several points in connection with low-temperature research, at Liverpool. It is owing to the relative pressures of oxygen and nitrogen in the air that the result occurs. The method employed for measuring low temperatures is stated to consist in using a system of five thermo-junctions, so arranged that three of them are kept at 0deg., whilst the other two are of the same metals but in the inverse order, so that when one of them is cooled the other must be heated in order to preserve equilibrium. The low temperature to be observed is thus balanced by a high temperature which can easily be read off. Hydrogen and helium remain yet to be liquefied, and of the two it seems as though helium were the less easily condensible. Moreover, it seems to have an abnormally low refractivity and molecular volume. Fluorine, in these respects, would appear to resemble helium. The ratio of the refractivity of hydrogen to that of chlorine is almost the same as that of helium to that of argon, and hence it has been suggested that a substance may yet be discovered which will be intermediate between these two elements

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just as fluorine is intermediate between hydrogen and chlorine. As to this, it has been pointed out in Germany that a periodic function can change from positive to negative by passing through ∞ as well as 0. If this is admitted, Mendeleieff's series can be rearranged, so that both argon and helium would fall into place as "transition" elements with unpredictable properties. But the conclusion that their molecule is monatomic at the temperature of measurement would have to be given up.

The Imperial Institute.—The extended organisation of the experimental branch of the scientific and technical research department of the Imperial Institute is now nearly complete, and the whole of the west corridor of the second floor is occupied by well-equipped laboratories, instrument-rooms, and sample examination rooms. The winter course of lectures will be opened on Monday, November 9, at 8.30 p.m., with a discourse by Prof. Wyndham Dunstan, F.R.S., the recently appointed director of the scientific department, the subject of which will be "Illustrations of Some of the Work of the Scientific and Technical Research Department of the Imperial Institute." After the lecture the research laboratories of the department will be open for the inspection of visitors, and a number of interesting exhibits will be on view. On November 16 Mr. William Crookes, F.R.S., will deliver the first of two illustrated lectures on the "Diamond Mines of Kimberley," in connection with which a number of specimens and experiments of great interest will be shown. Among other topics Mr. Crookes will discuss the nature and probable origin of the diamond, and will give an account of recent researches of his own. On the occasion of the first lecture Lord Loch will preside. On the two remaining Monday evenings in November illustrated lectures will be given by Prof. J. W. Judd, C.B., F.R.S., the dean of the Royal College of Science, on "Rubies, Natural and Artificial, with Special Reference to their Occurrence in the British Empire" (November 23), and by Dr. J. H. Bryan, F.R S., on "Flight, Natural and Artificial" (November 30). Among succeeding lectures, the dates of which will be duly announced, is one by Prof. W. E. Ayrton, F.R.S., on "Sixty Years of Submarine Telegraphy." These lectures are open to Fellows of the institute and to persons introduced by them.

Lightning Conductors at St. Paul's.—"For about 60 years after Wren's cathedral was completed," says the *City Press*, "there were no lightning conductors of any sort." The reason of this is exceedingly obvious. It was in 1769 that under the recommendation of a committee of the Royal Society the metal work of the lantern was connected to the lead of the dome by means of strips of lead and 1¼in. square iron bars, the lower portion of the lead roof of the dome being connected to the downspouts on the stone gallery, and so to the downspouts of the roof of the nave, and ultimately with the ground, into which the lead downspouts pierced for 3ft. The pineapples on the summits of the western towers were similarly connected to the ground by way of the nave roof. Considering what was known at the time—the great dispute as to ball or pointed ends was yet to come—the arrangement appears to have been a good one, and as a matter of fact proved effective. The danger that subsequently arose was not, as it happened, owing to the necessary ignorance of the designers of the system of protection, but to want of care in the upkeep, for when in 1873 these arrangements were examined it was found that not only had the iron rods rusted so as to be in themselves a positive source of danger, but that in many cases the old iron hoods of the rain-pipes, which hoods had originally acted as the connection between the rods and the pipes themselves, had been exchanged for granite hoods 6in. or 8in. thick. Upon this state of affairs becoming known, the Dean and Chapter appointed Mr. Faulkner to provide efficient protection against lightning, with the result that the top of the cross surmounting the dome and the tops of the pineapples on the western towers were then connected with the sewers in a manner believed to be capable of thoroughly protecting the cathedral from any peril by lightning whatsoever. It is believed that St. Paul's was the first building in London which was protected against lightning.

Liverpool Engineering Society.—At the opening meeting of this society the president-elect, Mr. S. B. Cottrell, M.I.C.E., M.I.M.E., delivered his inaugural address. Having sketched the general expansion of railways, Mr. Cottrell came to the main point of his address—electricity as applied to traction. Electromotive power, Mr. Cottrell said, began in earnest with the opening of the first electric railway in Berlin in 1879. The subsequent growth of electric rails and tramways in this country, on the Continent, and in the United States and Canada, where 90 per cent. of the street railways are worked by electromotive power, was referred to, and the special value of electric traction for the purpose of inter-communication in cities. In London the worst deficiencies in this respect were about to be remedied by new underground electric railways now authorised or in course of construction. By the application of electricity, the notorious discomforts of the London Underground would doubtless before long become a mere record. Discussing the application of electricity to main lines of railway, Mr. Cottrell said that the application would mean a different class of electric traction to that now employed. The present system of 500-volt continuous current had to be limited to a distance within 12 miles with any degree of economy, but by doubling the present working voltage the cost of transmission would be enormously lightened. A 1,000-volt current would not be impracticable under proper conditions as to safety. It would reduce the cost of conductors to one-fourth the present amount, and the problem would be enormously simplified by operating roads 30 or 40 miles in length from a single power station, while these stations, if placed where coal and water were abundant and worked by latest labour-saving appliances, would reduce the cost of output to a minimum, and enable power to be economically transmitted at high voltage to transferring sub-stations on branch lines up to 150 miles away. If the suggested speed of 100 to 120 miles an hour was ever to be attained, it would be by the electric locomotive. There was practically no limit to the rotary motion of an electric motor, while, unlike the steam locomotive, where the speed was increased by increasing the size of the driving wheels, and thus reducing the tractive power, the wheels might be of small diameter, which reduced the wheel base and gave the highest efficiency of tractive power. The Heilmann locomotive made a great stride in advancing electric traction, since it did not involve the use of power stations. This locomotive generated its own electricity, which was conveyed to motors fixed on the wheels. The whole weight of the locomotive was utilised for tractive purposes, and was unlike the steam locomotive in this respect, since in the latter only a small part of the weight was so made use of. Another advance was the discovery (ascribed to Mr. Tesla) of the rotating magnetic field and the construction of a motor which dispensed with commutators and brushes, always a source of trouble and expense. These improvements pointed to others, and showed that the record of railway development, one of the most interesting chapters of practical science, was far from closed.

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BURY ELECTRICITY WORKS.

Bury is supposed to have been a Roman station, and is a place of considerable antiquity. The town stands on the east bank of the River Irwell, and is about two miles from the confluence of the Irwell with the Roach—nine miles north of Manchester. It was incorporated by Royal charter dated September, 1876. The greater portion of the population, numbering some 60,000, are engaged in the cotton trade, though woollen manufacture still employs a large number of hands. The town hall and assembly rooms, situated in Market-street, were erected at the expense of the Earl of Derby, K.G. The police office and the magistrates' room, in which the petty sessions and courts are held, form part of the town hall buildings.

COUNCILLOR ASHWORTH, CHAIRMAN OF ELECTRIC LIGHT COMMITTEE.

MR. JOHN HASLAM, TOWN CLERK.

MR. JOHN HALL, MAYOR OF BURY.

The question of adopting electric lighting in the town was first mooted in 1882, but the decision was eventually arrived at that electric lighting for practical purposes was in too experimental a stage to justify the Council in spending ratepayers' money. However, in 1890 notice was given by a private company of their intention to apply to the Local Government Board for a provisional order authorising the supply of electricity within the borough. This move decided the Corporation to again consider the whole question, and a committee was accordingly formed to deal with the matter. The deliberations of this committee resulted in a provisional order being applied for on behalf of the Corporation to prevent private companies getting in. The order was duly granted in 1890, and Dr. John Hopkinson was soon afterwards called in to prepare a report and to advise the Corporation as to the best method to adopt in lighting the town. In his report, duly submitted in the following year, Dr. John Hopkinson recommended the adoption of a low-pressure system as being best suited to the configuration of the town. But the matter hung fire, no decision being arrived at to carry out the scheme. It was not until it was evident that the gasworks, which, by-the-bye, are in the hands of the Corporation, were becoming too small to cope with the town's demand for gas that the question of electric lighting was really seriously gone into.

MR. E. M. LACEY, A.M.I.C.E., CONSULTING ELECTRICAL ENGINEER.

MR. J. CARTWRIGHT, M.I.C.E., BOROUGH ENGINEER.

Early in 1893 the Electric Lighting Committee paid a series of visits to different towns which had taken up the

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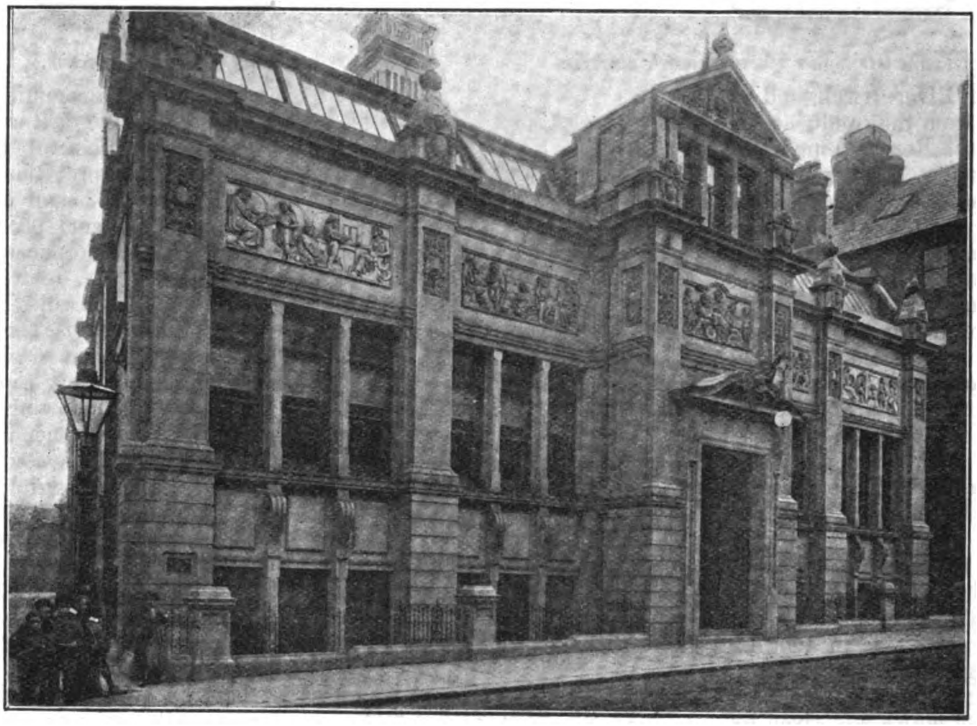
supply. They inspected the electricity works at Oxford, London, Eastbourne, Woolwich, and Cambridge. In their report they stated that they considered "the Corporation to be bound to do something at an early date to carry out the electric lighting order they had obtained." The chief difficulty which troubled the committee was the choice between the continuous and alternating systems. They recommended that a number of preliminary tenders should be obtained, leaving the tenderers full liberty to adopt and recommend such systems and types of motive power and dynamos as they may deem best suited. The matter was placed in the hands of the able borough engineer, Mr. J. Cartwright, M.I.C.E., who gave the competitors all the leading data to be fulfilled in tendering. The result of the above course was that 12 firms sent in tenders, which varied so largely in detail and in the design of the plant offered that Mr. Cartwright advised the Council to obtain expert advice on them.

In consequence, a borough electrical engineer was appointed to work with Mr. Cartwright in the matter. Mr. Wynne was chosen for this work, and reports from both these gentlemen were considered by the Corporation early in 1894. It was decided to adopt a low-tension three-wire system with accumulators, and that new tenders on this basis should be invited. Mr. Wynne shortly afterwards resigned his position, and the new specification was prepared by Mr. J. Cartwright. Mr. E. M. Lacey, A.M.I.C.E., consulting engineer, of 10, Delahay-street, Westminster, was, however, retained to co-operate with the borough engineer in electrical matters. In March, 1895, powers to borrow £30,000 were granted after an enquiry, and from that time the work has not been checked. It will be gathered from the above that the brunt of the work has fallen on the shoulders of Mr. J. Cartwright, and he is to be congratulated on the successful completion of the station opened yesterday. His coloborator, Mr. Lacey, has had an extensive experience in electrical work. He held appointments on the staffs of the Health, Inventions, and Colonial Exhibitions. Since 1892 Mr. Lacey has practised on his own account in the profession of consulting engineer, and during this period has, amongst other public bodies, advised the Corporations of Bournemouth, Bury, Darwen, and Blackburn. Mr. Lacey at the present has in hand several important works, and amongst these may be mentioned the extension of the Blackburn Corporation electricity works, the electric traction scheme for the Blackburn tramways, and the electrical installation at the Blackpool Winter Gardens, where a plant of upwards of 1,200 h p. is being put down.

The area to be supplied at Bury is a fairly good district, and although no canvass or attempt whatever has been made to secure customers, yet the equivalent of about 800 8-c.p. lamps has already been wired. The work of adding to this number is still going on merrily. The tradespeople and private residents are likely to be the largest consumers, as although there are many large factories in the town the principal ones have their own installations, spare power being utilised. The municipal buildings have not yet been wired, but the work is to be proceeded with shortly. Of the other public buildings perhaps the principal is the technical school, a photograph of which we reproduce. This truly magnificent structure was designed by Mr. J. Cartwright also, and has only been completed about a year. It at present has its own installation of electric light, the number of lights installed being equivalent to 300 16 c.p., but it is probable that the institute will shortly be connected on to the Corporation mains, the present system of running by means of a gas-engine being found to be none too satisfactory. Altogether, although the number of lamps connected at present to the mains is small, there is every promise that the number will rapidly be augmented. Gas is supplied in the district at about 2s. 1d. net, and the price per unit for electrical energy has been fixed at 6d. with a rental for meters according to capacity. As mentioned above, the sum of £30,000 was borrowed to cover the cost of the electric light undertaking, but of this amount only about £15,000 has been actually expended, £5,000 of which represents the cost of the buildings. The contract for the erection of the requisite buildings was given to Messrs. Storrs and Sons, of Stalybridge, in September, 1894. The order for the necessary plant and supply mains was awarded to Messrs. Siemens Bros. in November, 1895.



THE ART SCHOOLS, BURY, DESIGNED BY MR. J. CARTWRIGHT.

Buildings.

The site of the station buildings is conveniently situated almost in the centre of the district to be supplied, and is Corporation property, there being room for unlimited extension. The buildings (designed by Mr. J. Cartwright), the general arrangements of which can be gathered from Figs. 1, 2, and 3, are of red brickwork with stone dressings, and comprise offices, storerooms, workshops, accumulator-house, boiler-house, engine and dynamo room. The area covered is 10,000 square feet. At present the approach is from Back Derby-street, but the principal entrance will ultimately be from Rochdale-road. The accumulator-house has a floor space of 1,550 square feet; the walls are lined with salt-glazed bricks of a brown colour, while the floor is paved with Staffordshire chequered blue bricks laid on 6in.

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of concrete. The accumulator cells are supported on low walls of salt-glazed bricks running parallel with each other down the length of the room, and ample light is obtained

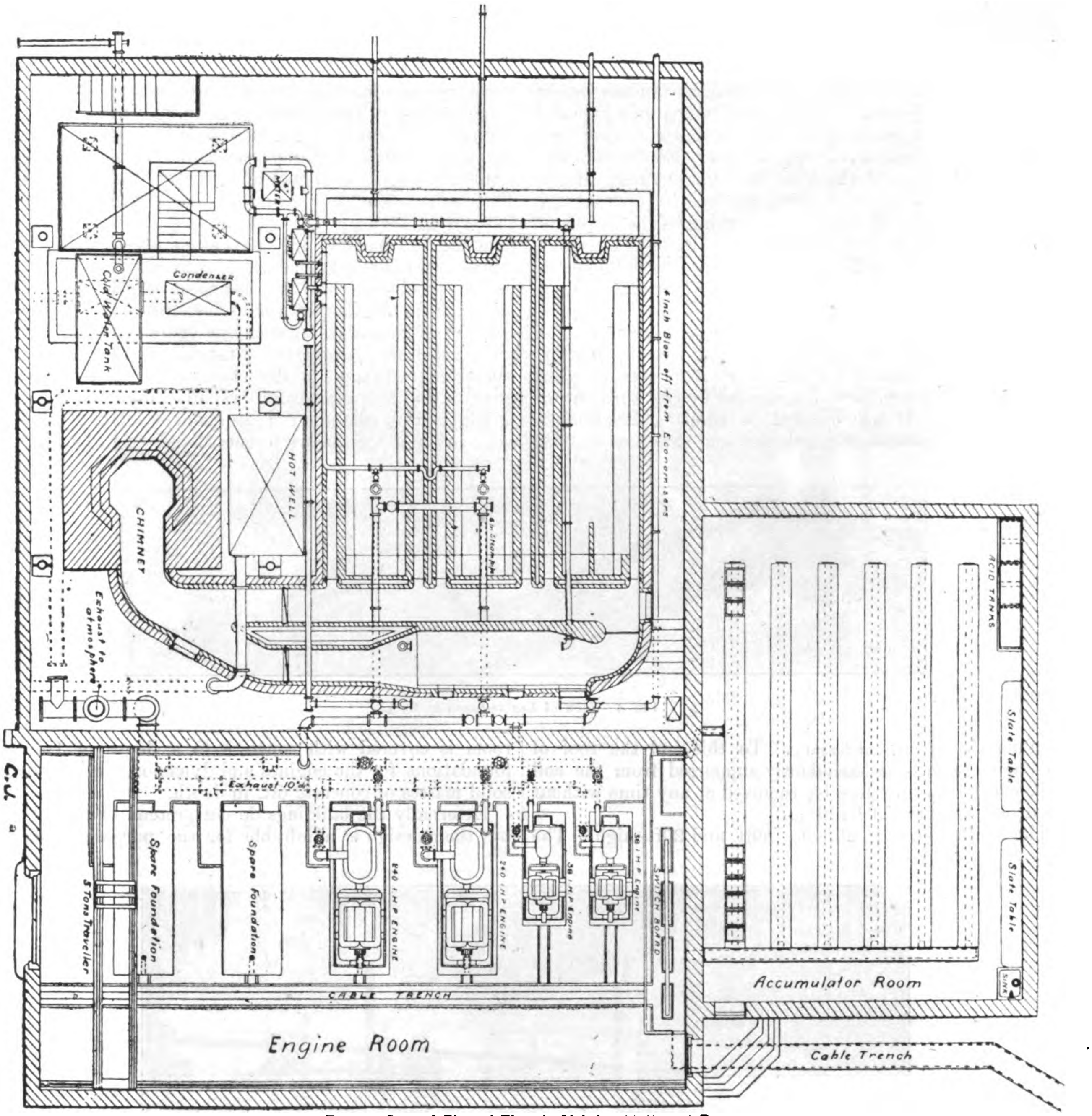

Fig. 1.—General Plan of Electric Lighting Station at Bury.

through windows along the south wall. Ventilation is provided for by means of a continuous open ventilator running the entire length of the roof, which, by the way, is of deal.

The engine-room is 60ft. by 30ft., height 36ft. to ridge, and the walls to dado height are lined with brown and

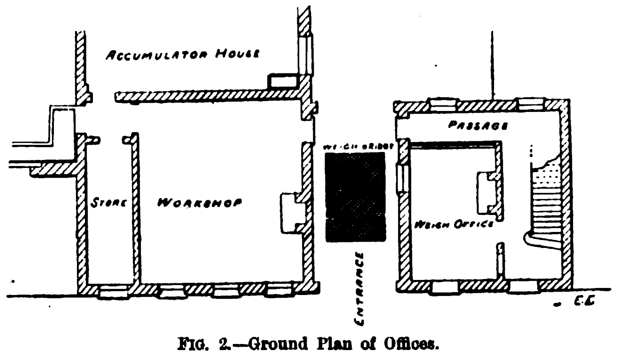

Fig. 2.—Ground Plan of Offices.

cream coloured glazed bricks, as can be seen in Fig. 4. The upper portion of this work is done with Aston Hall bricks. The floor is paved with encaustic tiles, with pattern border, and the roof is of iron, boarded with 1½in. boards on the angle. Lighting is effected from the westerly side by windows of fair proportions, by a lantern light in the roof, which also serves the purpose of a ventilator, and by skylights in the roof, also used as ventilators, which can

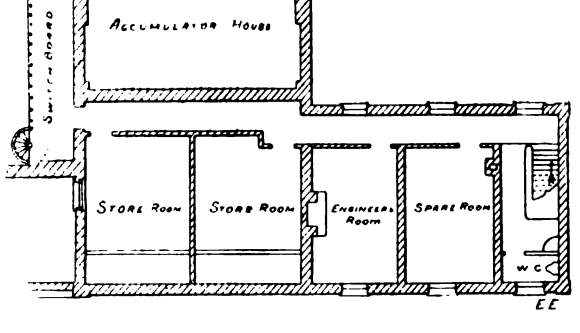

Fig. 3.—First Floor Plan of Offices.

be opened from the floor level. A travelling crane to lift 10 tons, worked by means of hand power, supplied by Messrs. Carrick and Ritchie, of Edinburgh, runs the entire

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length of the room, being supported on moulded stone corbels 20ft. from the ground level. The floor space is amply sufficient to allow of plant double the present capacity being installed without any extensions. Provision is also made for extensive additions to the present building should such become necessary. To this end the roof of the engine-room is independently supported from the end wall, which can therefore be removed at any time without disturbing the present building.

The boiler-house is 60ft. by 60ft. and 20ft. high. The roof is of iron in two spans, supported by girders and columns, and has louvre ventilators. Three large doorways, fitted with revolving steel shutters, are provided through which to tip coal. Accommodation is provided for another boiler when extensions become necessary. The chimney shaft rises through the roof of the boiler-house; it is 14ft. square for a height of 48ft., the remaining portion being octagonal in form and surmounted with a terra-cotta top. The shaft is lined with firebricks for a height of 60ft., the total height being 150ft. No difficulty has been experienced in obtaining good foundations. The floor of the engine-room is covered with concrete to a depth of 1ft., while foundations for the engines and dynamos are provided by solid masses of concrete 6ft. in depth.

Externally the buildings do not pretend to much beauty, but their design is admirable for the purpose which they serve, and forethought has been shown for future extensions. It is quite probable that extensions may be necessary at an early date, for we understand that the tramway company is negotiating with the Corporation for the supply of current necessary to work a portion of their extensive system electrically on the overhead trolley system. In the

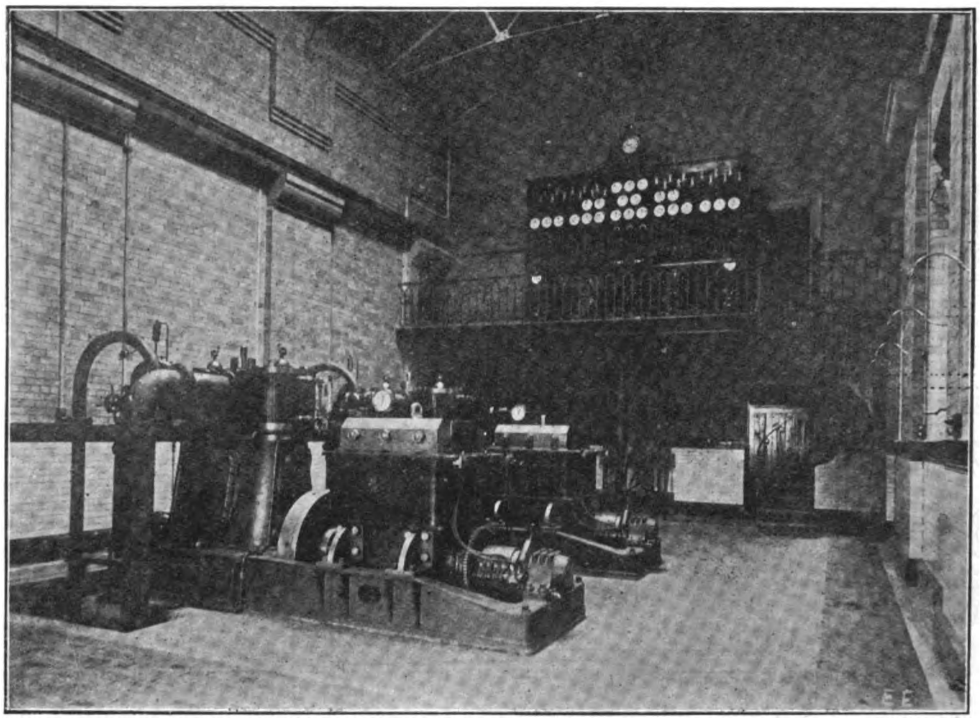

FIG. 4.—View of Engine-Room at Bury.

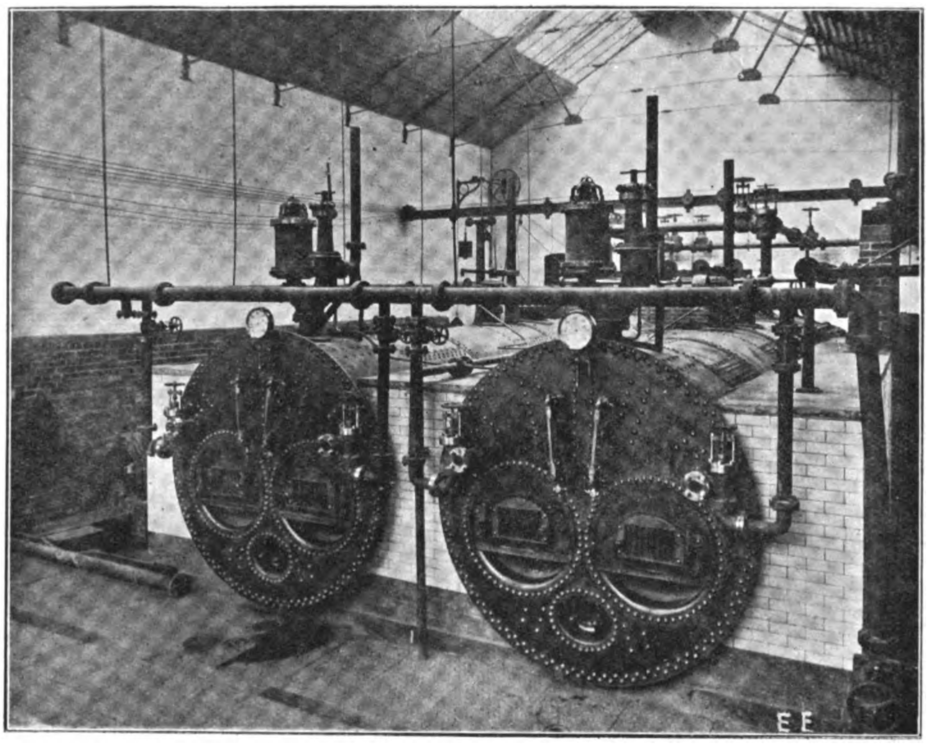

FIG. 5.—View of Boiler-House.

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event of the successful issue of these negotiations, Bury will be able to boast of its electrically-driven tramcars, and will also gain a useful power load for its electricity works. The two large dynamos in series would give the voltage required, so that new plant interchangeable with the old

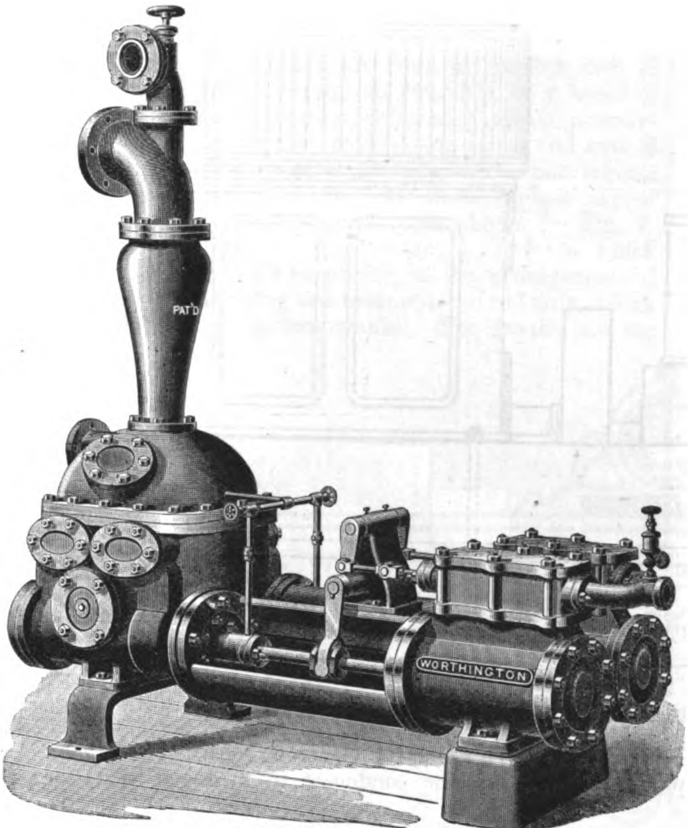

FIG. 6.—Worthington Jet Condenser.

could be added. A weighbridge (Fig. 2) is provided at the Back Derby-street entrance to the generating station for weighing all coal or other material that may enter the yard. The offices are spacious, and very conveniently arranged; the testroom adjoins the offices. A separate contract was entered into by the Corporation with Messrs. J. H. Heywood, of Manchester, for wiring the whole of the premises. For lighting the engine-room, yard, and approaches, this firm have used arc lamps manufactured by Messrs. Crompton and Co. We may add here that a few arc lamps will be put up by the Corporation for experiment, but no street-lighting on an extensive scale has yet been decided upon.

Steam Generating Plant.

As mentioned above, Messrs. Siemens Bros. are the contractors directly responsible to the Corporation for the whole of the machinery and mains; but sub-contracts were entered into by them. Thus, the boilers were supplied by Mr. W. Lord, of Bury. Two of the Lancashire type of boilers were required, and a general view of these in their seatings is shown in Fig. 5. Each boiler is 30ft. long and 7ft. diameter. The two tubes taper in diameter from 2ft. 9in. at the furnace end to 2ft. 3in. at the other end. The shell plates are of $\frac{11}{16}$in. mild steel. The first ring of the main tubes is of $\frac{5}{8}$in. steel, the rest being $\frac{1}{2}$in. There are no cross tubes. These boilers were designed for a working pressure of 150lb. per square inch, and were tested under a hydraulic pressure of 300lb. per square inch. All the usual boiler mountings are supplied, and the Hopkinson type of fitting and valve has been used throughout. These boilers are fed by two Worthington pumps, each of which is capable of keeping the full load in the station going. Each of these pumps has cylinders $4\frac{1}{2}$in. diameter, plungers $2\frac{3}{4}$in. diameter, with a 4ft. stroke. These pumps are so arranged that water may be pumped to the boilers direct from a cold-water tank (of 8,000 gallons capacity, replenished from the town mains), from the hot-well through the Green's economiser which has been provided, or direct from the hot-well to boilers. This fuel economiser has 120 heating tubes, each $4\frac{9}{16}$in. diameter and 9ft. long, and was made by E. Green and Son, Limited, of Manchester and Wakefield. It is placed in the flue between the boilers and chimney stack. This apparatus has been constructed from strengthened patterns throughout, and is of Messrs. Green's high-pressure type. It is arranged in rows six tubes wide, with a passage along the back for inspection and cleaning purposes. The test pressure applied before the economiser was passed was 350lb. on the square inch. The scrapers in this economiser are actuated by a $\frac{1}{2}$-h.p. electric motor placed in the boiler-house.

Steam and Exhaust Pipes.

These, together with the tanks, were supplied by John Abbott and Co., of Gateshead-on-Tyne. The pipes are of lap-welded mild steel with flanges welded on, with copper bends and cast-iron T-pieces The steam-pipes are arranged on the ring system, and the steam for the engines may be taken either way round the ring. Valves are placed between each engine and between the boilers, so that any section can be cut off independently of the others for repairs, etc. A feature which strikes one on entering the engine-room is the absence of unsightly steam-pipes (Fig. 4). The reason of this is that these, together with the

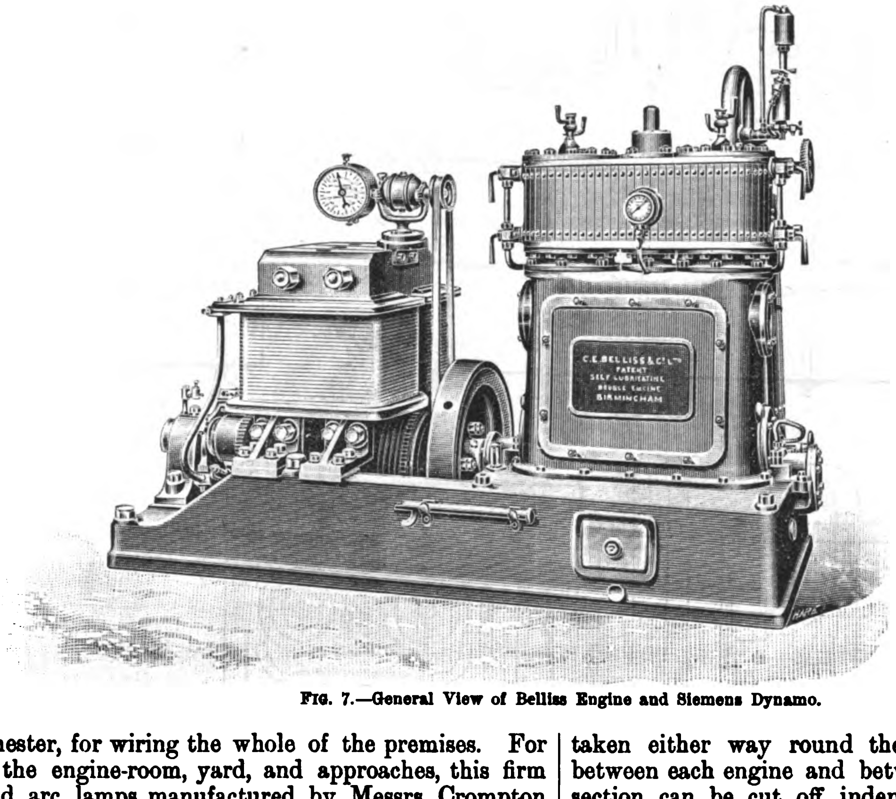

FIG. 7.—General View of Belliss Engine and Siemens Dynamo.

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exhaust steam-pipes, etc., are laid in brick trenches below the floor, at the back of the engines, and covered with neat iron gratings. This trench is approachable from the boiler-house and affords ample room for inspection and repairs. The exhaust-pipes are of cast iron, varying in diameter up to 14in., and are supported in the same way. The exhaust is at present carried into the atmosphere, the pipes going

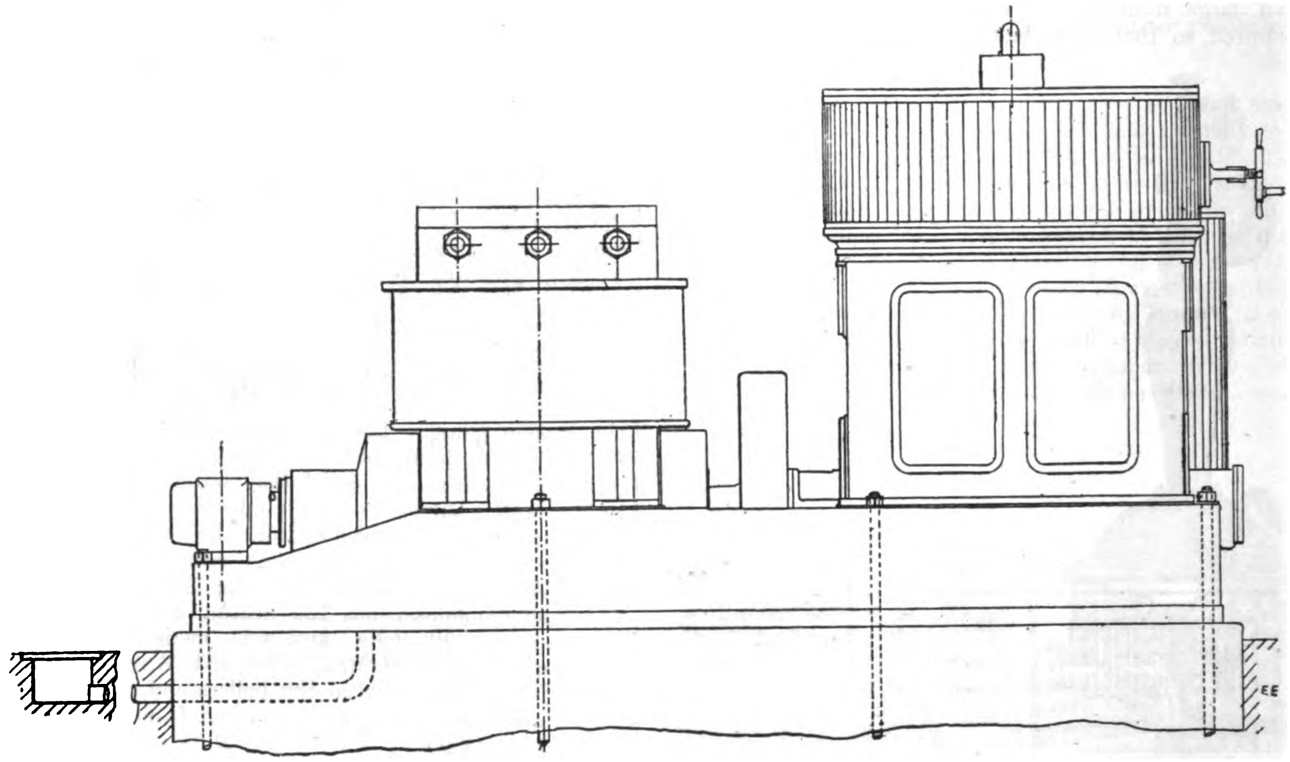
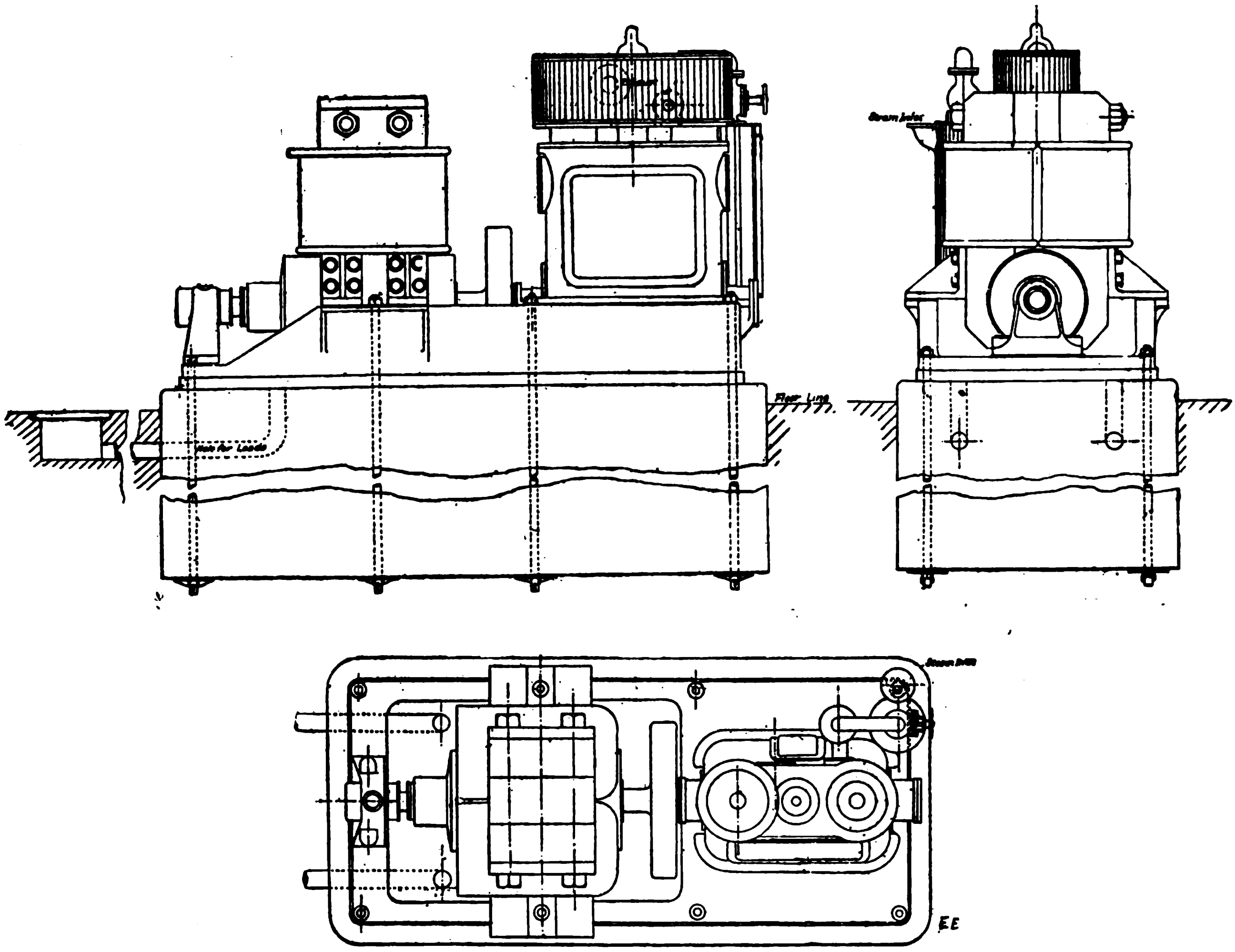


FIG. 8.—Elevation of 240-i.h.p. Belliss Engine Coupled to Siemens Dynamo.

through the boiler-house roof independent of the chimney shaft (Fig. 1). A Worthington jet condenser is, however, being erected. This apparatus (Fig. 6) consists of a duplex pump and an injector condenser so arranged that the momentum of the incoming injection water and exhaust steam is employed to assist the pump in maintaining the vacuum in the condenser. The diameter of the steam-



FIGS. 9, 10, and 11.—Plan and Elevations of 88-i.h.p. Belliss Engines Coupled to Siemens Dynamo.

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cylinders is 9in., while that of the pump plungers is 12in., the length of stroke being 10in. The necessary condensing water will be obtained from the Barnbrook stream, which runs in close proximity to the station.

Engines.

These have been supplied by Messrs. G. E. Belliss and Co., of Birmingham. They are four in number, two of them designed for an output of 240 i.h.p. at a speed of 350 revolutions per minute, working at a steam pressure of 140lb. per square inch at engine stop-valve, and two of 38 i.h.p. working at a speed of 560 revolutions per minute with the same steam pressure. All these engines are of the Belliss two-crank compound type, shown in Fig. 7. A special feature of this type of engine, and one which contributes largely to its simplicity, is the arrangement of the slide valves, requiring one eccentric and rod only, which is placed in between the two cranks. The cranks are set opposite to each other, the steam being admitted simultaneously to the top of one cylinder and the bottom of the other, by which arrangement the reciprocating parts are to a great extent balanced and the strain on the bearings much reduced. The engine is fitted with a centrifugal governor, carried on the crankshaft, and connected to an equilibrium throttle-valve. The governor gear is arranged so that the speed of the engine is capable of being adjusted through a wide range of variation whilst running. Forced lubrication is provided throughout, and the makers claim that their double-acting engine is capable of exceptional efficient lubrication.

Dynamos.

All the dynamos were, of course, manufactured by Messrs. Siemens Bros. and Co. The two large dynamos, of the H.B. $^{24}/_{36}$ type, are coupled to the 240-h.p. engines (Fig. 8), and were specified to give 500 amperes at 260 volts. They are shunt-wound, the shunt regulation to be sufficient to allow of an output of 500 amperes at from 220 to 250 volts, while the remaining 10 volts may be obtained by raising the speed to 350 revolutions per minute. The smaller pair of dynamos (Figs. 9, 10, and 11) are of the H.B. $^{15}/_{16}$ type, capable of giving 144 amperes at from 110 to 145 volts, with a speed of 500 revolutions, but a rise of speed to 560 revolutions will allow of the voltage being raised to 160 volts. At the lower voltage the machines can give 200 amperes. All the armatures are drum-wound, and the bearings are provided with ring lubrication, and a tachometer is supplied with each set. Combination bed-plates, extending under both engine and dynamo, are used for both the sizes above mentioned.

These engines and dynamos were tested at Messrs. Belliss and Co.'s works before being delivered. All the sets were run on full load for some 10 hours. We have been kindly allowed to see a copy of these official tests, and gather from them that the two large sets were put through the 10-hour trial at the same time. From the figures as to boiler pressure and pressure in the valve chest, it is seen that the small section of the steam-pipes used caused a considerable fall of pressure. Hence the efficiency figures suffered. The tests we give were made when one set only was running at varying loads.

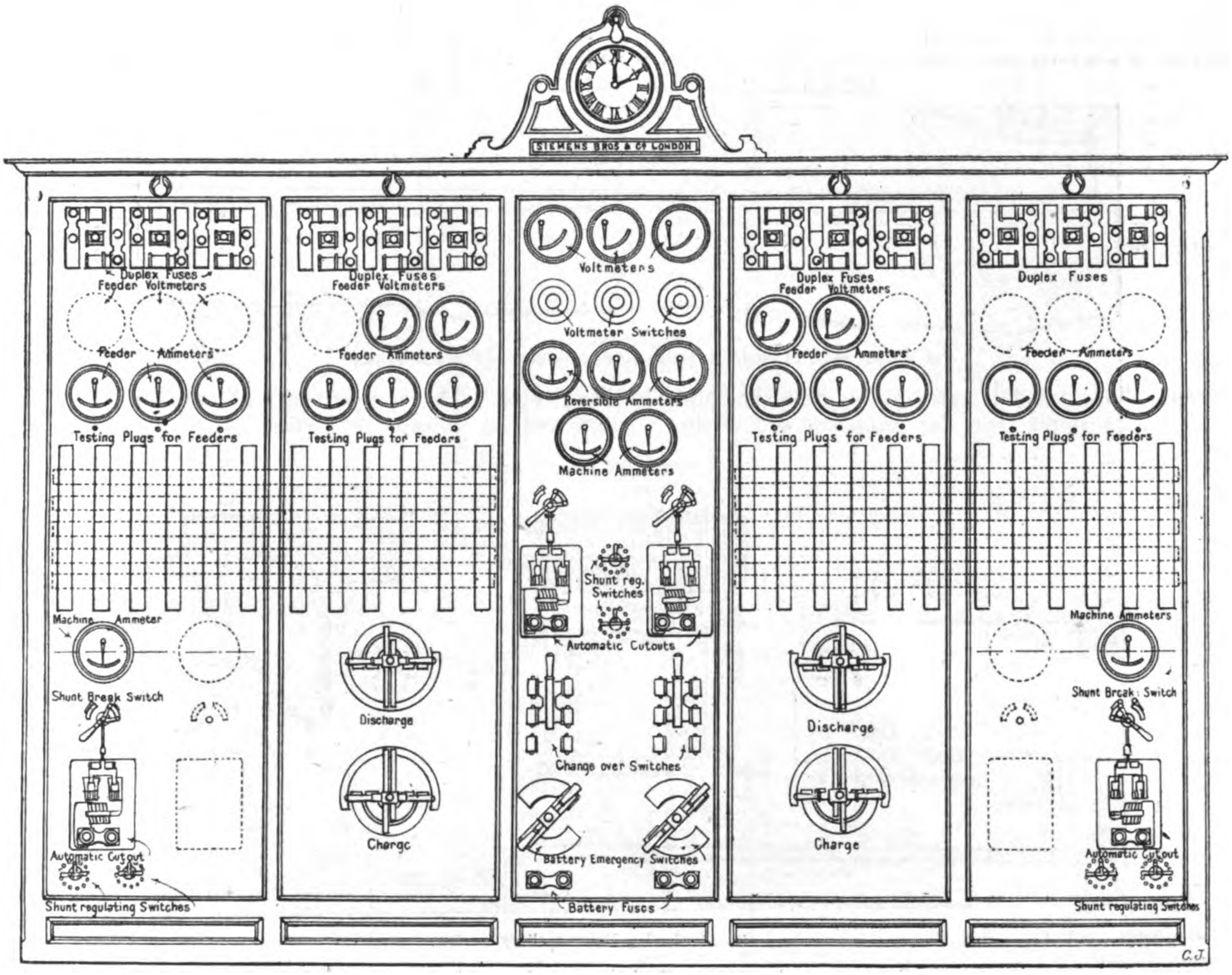

Fig. 12.—The Switchboards, Bury.

Belliss Engine No. 421 Coupled to Siemens H.B. $^{24}/_{36}$ Shunt Dynamo—Test when Exhausting into Condenser.

	Full load.	Half load.
Boiler pressure, pounds per square inch	145	145
Vacuum in inches	27·5	27·5
Pressure in steam-chest, pounds per square inch	95	49
Revolutions per minute	352	350
Amperes	490	238
Volts	262	253·5
Electrical horse-power	172 2	81
Indicated " "	203	96·8
Efficiency $\frac{\text{E.H.P.}}{\text{I.H.P.}}$	84·8	83·6
Pounds of water per hour	3,216	1,854
" " " I.H.P.	15·84	19·15
" " " E.H.P.	18·67	22 88

The engine No. 420, which is similar in every respect to that tested above, was then run at full load, exhausting into the atmosphere. The average of three tests for water consumption gave the following figures: Boiler pressure, 143lb.; pressure in steam-chest, 135lb.; speed, 349·5 revo-

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lutions; E.H.P. = 177·8; I.H.P. = 212·6; efficiency, 83·6 per cent.; pounds of water per hour, 4,249; pounds of water per I.H.P. = 19·98; ditto per E.H.P. = 23·86. A set of friction cards taken on the same engine showed 22 i.h.p. at no load. Assuming that this friction loss is constant at all loads, as we are justified in doing, this will give a ratio of $\frac{\text{B.H.P.}}{\text{I.H.P.}}$ = 89·65 per cent.

The governor trials of these two engines gave the following results. The full load was switched off suddenly to test the regulation of the governors:

	Revolutions per minute. No. 420		No. 421
Load on	349	362	350
Load off	367	367	365
Momentary increase	410	395	415

The following are the temperature rises after the 10-hour run at full load:

Temperature of test-house, 95deg. F.	No. 420	No. 421
Temperature of field magnets	154	150
Temperature of armature engine end	122	125
Temperature of armature commutator end	113	120

The temperatures of the various parts of the dynamos after the 10-hour full load run were as follows:

Temperature of test-house, 95deg. F.	No. 222	No. 223
Temperature of field magnets	110	112
Temperature of armature	111	112

Governor trials made by throwing the full load suddenly off:

	Revs. per min. No. 222.	No. 223.
Load on condensing	550	500
Load off condensing	560	512
Momentary increase condensing	600	590
Load on non-condensing	—	500
Load off non-condensing	—	513
Momentary increase	—	575

Switchboard.

The switchboard (Fig. 12) has been supplied by the contractors for the whole of the plant and mains (Messrs. Siemens Bros.), and consists of five panels of enamelled slate supported on an iron framework. It is essentially a plug switchboard of Messrs. Siemens Bros.' latest design. All the instruments, switches, etc., are of the firm's make. Two panels contain the battery charging and

FIG. 13.—Laying Mains at Bury.

discharging switches—one for each side of the three-way system—with the usual arrangements for throwing-in additional cells to keep pressure constant or to take them out, as the case may be. The connection and plugging switches are so arranged that any one dynamo and circuit can be isolated from the 'bus bars and run independently. Duplex fuses are provided for the feeders. Space is left on the board for two more machines and four more feeders. As will be gathered from the illustration, each three-wire feeder is provided on the board with two ammeters, two pilot voltmeters, but no switch, so that only a failure of the fuses can cut off the supply. The two smaller dynamos are used to charge the accumulators, and the change-over switches on the centre panel allow either machine to charge either set. The large dynamos, on the other hand, are always connected to the two outside wires of the network. All the machines are protected against excessive or return current by automatic cut-outs.

The switchboard is erected at the south end of the engine-room on a gallery which is reached by a circular iron staircase.

Thus the maximum rise on the field was only 59deg. F., while that of the armature never exceeded 30deg. This shows that the dynamos are capable of giving considerably more than their rated output.

The two smaller sets of engines and dynamos were put through similar trials, with the results given below:

ENGINE No. 222—EXHAUSTING INTO CONDENSER.

	Full load.	Three-quarter load.	Half load.	Quarter load.
Boiler pressure	146·5	140	143·3	146·3
Pressure in steam-chest	131·5	—	—	—
Vacuum	23·5	24	24	24
Revolutions per minute	500	505	503	503
Amperes	203	137	100	53·3
Volts	114	110	109	112
Electrical horse-power	31	20·2	14·6	8
Pounds of water per hour	796	504	389	238·5
„ „ „ „ E.H.P. hour	25·67	24 9	26·5	29·75

In the combined condensing trials for 10 hours of these two engines and dynamos at full load better consumption figures than the above were obtained. The water per electrical horse-power hour came out at only 24·4lb. The friction cards on one of these sets indicated 3·77 h.p. at no load, which shows a commercial efficiency of 89·6 per cent. at full load.

Accumulators.

These are of the E.P.S. type, and the 130 of the K-54 type

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cells are arranged in two batteries in series, each containing 65 cells. The plates are placed in lead boxes and equipped with all the usual accessories, including hydrometers and sheet-glass spray catcher. Spare acid is contained in an ebonite cistern at one end of the room. This cistern is provided with an ebonite valve and indiarubber hose pipe, so that acid can be easily put into any battery requiring it. The whole of the cells are connected in series, the centre cell and those at each end being connected to the switchboard.

Mains.

The whole of this work was placed in the hands of Messrs. Siemens Bros., but the trenching and making good the footpaths was done by the Corporation under Mr. Cartwright's supervision. A three-wire system of distributing mains with three-wire feeders is provided, the voltage of supply between two adjacent wires being 110. A few consumers have, however, been connected across the outside wire, taking their supply at 220 volts. The cables used for distributing mains consist of a strand of 37 wires ·071in. diameter for the outside wire and 19 ·064in. wires for the inner conductor. About 3,000 yards of this distributing system have been supplied and laid. This network is fed at two points—one in Fleet-street, near the corner of Union-street, and the other at the junction of Princes-street with Market-street. Both these feeders are about 700 yards long. All the mains and feeders are insulated with vulcanised rubber tape and braided, and these are drawn into 4in. cast-iron pipes. The method of laying the mains, etc., is shown in Fig. 13, while Fig. 14 shows a section of a street box. The station is at one end of the area supplied, and the streets now provided with mains include, besides those mentioned, Moss-street, Silver-street, Broad-street, King-street, Rock-street, Clough-street, and Rochdale-road. The house connections are drawn into 2in. wrought-iron pipes from house service boxes placed every 20 yards or so along the street. These boxes are usually of glazed brick, but concrete is used in some places.

The resident electrical engineer is Mr. S. J. Watson, who has been recently appointed. The charge authorised for the supply will be 6d. per Board of Trade unit, and meter rents will also be adopted. The whole of the meters

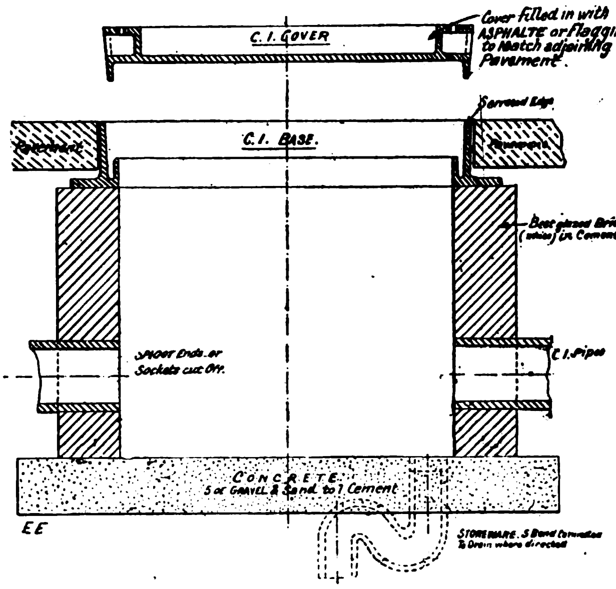

FIG. 14.—Section of Street Box.

for consumers have been supplied by Messrs. Chamberlain and Hookham, while the station meters are of the Elihu Thomson type.

CROYDON ELECTRICITY WORKS.

The scattered town of Croydon, although only recently incorporated, has a history extending back into Lanfranc's time. This eminent bishop built the archiepiscopal palace, which fell into disuse in 1757, and now is in ruins. The town has grown rapidly of late, and now has a population of over 100,000. Its corporate spirit is shown by the splendid municipal buildings it has erected, which were recently opened by the Prince of Wales.

The electric light has been the cause of much agitation in Croydon, and a perusal of our back volumes will repay for turning up references under the heading of "Croydon." Thus, we find that in November, 1889, no less than three companies gave notice that they were applying for a provisional order to light the town by electricity. The municipal fathers took counsel as to which of the three would offer best terms if the granting of their order was not opposed, but in the end could find "no best." This was about the time when the numerous House-to-House companies were projected, but the Croydon House-to-House Electric Lighting Company did not get a footing in the town. Finally, the Corporation applied for an order in self-protection, and were granted the necessary powers in 1891. Even then the companies tried to get transfers, and as a result tenders were asked for. The chief condition laid down to the persons offering to take over the order was that good repurchasing clauses should be given. No less than six offers were submitted to the Council early in October, 1892. The terms of these offers are given on page 367 of vol. x. of the *Electrical Engineer*. In the report on these it is noted that "under either of the offers, if the Corporation should desire to repurchase the undertaking, they will have to pay a substantial profit upon the sums actually expended by the contractors, and they may find themselves in the position of having to take over a considerable amount of plant which at the time of purchase may be out of date and of little value, but which the Corporation will have to acquire, not at its then value, but at a considerable premium on its original cost." Taking all these considerations into account the committee recommended "that the Council should carry out the powers of the provisional order itself, either then or at a future date."

Mr. W. H. Preece was then called in to report on the advisability of placing a central station under the new municipal buildings, and presented his report early in 1893. The conclusions arrived at have now practically been carried out. The inconvenience of running a large number of private lights from an electric lighting plant in the basement of the town hall was pointed out, and the establishment of a central station elsewhere in the town was recommended. On the matter coming before the Council it was referred back by the casting vote of the Mayor. The matter was then shelved for a time, till in November, 1894, a resolution was passed to the effect: "That the Corporation should arrange with some company of undoubted stability to establish an installation for a compulsory area at such contract price as the consulting engineer of the Corporation may approve; that the Corporation should find the necessary capital for the above purpose; that the company should undertake to work the undertaking for a term of years to be agreed upon and to maintain the plant in thorough working order, taking the revenue to be derived from the undertaking and satisfactorily guaranteeing to pay the Corporation interest and sinking fund upon the capital expended; and that powers should be reserved to the Corporation to take over the undertaking from the company upon terms to be agreed at an earlier date than the expiry of the period stipulated in the first instance." From this it will be seen that a new departure in the methods of supplying a town with electric light plant was proposed, and the subsequent records show that the British Thomson-Houston assisted in the new venture. Thus in April, 1895, it was agreed: "That the Electric Lighting Sub-Committee be authorised to instruct the town clerk to make application to the Local Government Board for permission to borrow a sum not

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exceeding £27,500 for the purpose of electric lighting; that the sub-committee be authorised to instruct Prof. Kennedy to arrange with the British Thomson-Houston Company a detailed specification of such works as in the judgment of Prof. Kennedy will satisfactorily supply electricity to the central area, together with all necessary accessories at such contract price as Prof. Kennedy may approve. Provision to be made, as far as buildings and laying pipes to carry

ALDERMAN EDRIDGE, MAYOR OF CROYDON.

extra mains are concerned, for a considerable future extension of the system. That the sub-committee be authorised to order the corporate seal to be affixed to a contract with the British Thomson-Houston Company, Limited, subject to the sanction of the Local Government Board to a loan for the purpose of providing the necessary expenditure, and that the sub-committee be authorised to engage Prof. Kennedy to watch the interests of the Corporation in the matter and to see that the contract is efficiently carried out."

The full details of the arrangements between the British Thomson-Houston Company and the Corporation are too

ALDERMAN MILLER, CHAIRMAN OF ELECTRIC LIGHT COMMITTEE.

lengthy to publish, but the gist of the arrangements is as follows: The Corporation find all the capital required, and the contractors to work the station for a period of not more than 10 years, and to pay during that time the interest and sinking funds of the borrowed capital. The contractors, of course, take all the income, and have to provide for keeping the station in repair. When the station is taken over by the Corporation some payment has to be made for goodwill if the 10 years have not expired.

Buildings.

The station buildings at Croydon were designed by Mr. E. Haslehurst and erected by S. Page, of Borough-hill, Croydon. The station is situated near the Corporation's dust depôt at Brimstone Barn, which is a convenient site both for coal and water. It is expected that a siding to the works will be provided as the demand increases. The front view of the buildings, which include all the usual offices,

ALDERMAN MOSS, MAYOR ELECT, CHAIRMAN GENERAL PURPOSES COMMITTEE.

is shown in Fig. 1. The buildings are of substantial design, and in every way are a credit to the architect. The engine-room and boiler-rooms have a dado of glazed brickwork, and the ventilation has been especially looked after.

System of Supply.

The system of supply, although not altogether new, has many features worthy of special notice. The alternators in the station supply by independent feeders some four sub-stations. The high-pressure supply is at 2,000 volts, and is transformed down to 200 volts in the sub-stations. These sub-stations have also high-pressure links between

MR. E. MAWDESLEY, B.A., LL.B., TOWN CLERK.

them, so that in the case of a failure of one feeder the light need not be interrupted for any length of time. The low-tension mains provided can, if desired, be connected up as a network, but at present the links will be left out and each section fed independently. Thus each sub-station feeds some three or four sections of low-tension mains through fuses in the sub-station. No fuses are at present placed anywhere on the mains themselves. The higher voltage on the low-

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tension side—*i.e.*, 200 volts—is here applied for the first time for alternate-current work. This pressure makes the two-wire system as valuable as the three-wire system with the pressure of 100 volts, and also gives greater simplicity. The other novelties in the station itself will be referred to later on.

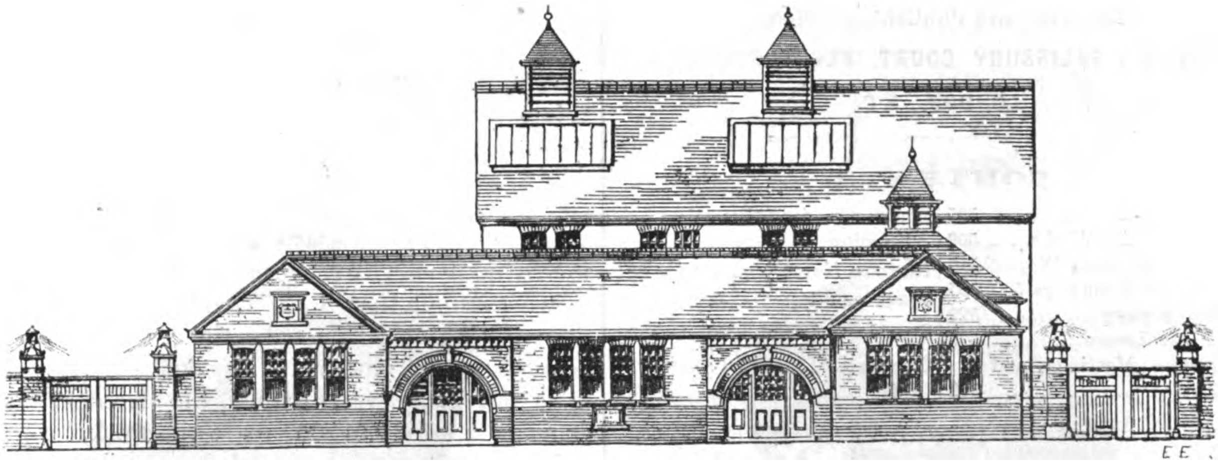

FIG. 1.—Front Elevation of Central Station at Croydon.

Steam Generating Plant.

The sub-contractors for this part of the work were Messrs. Davey, Paxman, and Co., of Colchester. They have supplied three of their steel "Economic" boilers. The position of these in their seatings can be seen in Figs. 2 and 3, while Fig. 4 shows a general view of the boiler-room. Both boilers are 14ft. long and 8ft. 7¼in. in diameter, and are fitted with 104 3in. diameter smoke-tubes. Each boiler has two main flues, 2ft. 10in. in diameter, and there are two circulating tubes in each flue. The total heating surface of the boiler is 1,316 square feet, and the working pressure is 160lb. per square inch. Each boiler is provided with Paxman's patent expansion boiler flue (see Fig. 5), the form of which gives it such strength that thinner plates can be used in its construction than it would be safe to use in the plain flue. This is a great advantage, as it is a well-known fact that the heat passes more rapidly through thin plates, which are thus rendered more durable because they do not overheat. In this way the full excellence of the material is retained for a great length of time. It is also well known that the strength and durability of a boiler depend greatly on there being proper provision made in its design for the inevitable expansion and contraction. Where this is not provided for, furrowing and ripped seams are the result. The flues, as illustrated above, provide for this without injuring the efficiency of the flue as a stay. The flue is made up of a series of short lengths of soft and exceedingly tough steel as shown. The plates are bent in such a way as to be perfectly cylindrical, thus adding to the strength of the flue. They are then carefully welded, and then the ends are heated in a furnace and enlarged in a powerful flanging machine in such a way that the end of one plate exactly fits within that of the next. The holes are then drilled through both, and riveting completes the work.

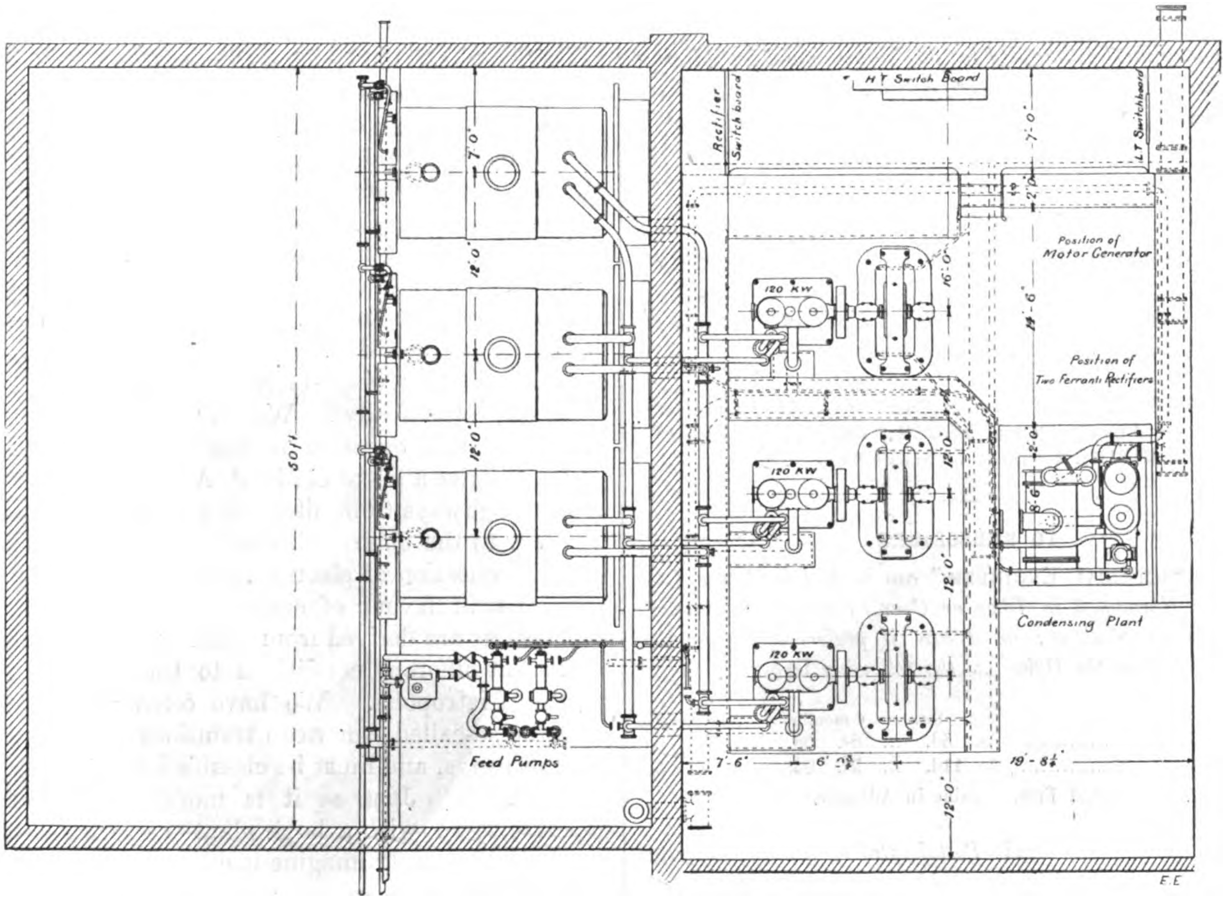

FIG. 2.—Plan of the Croydon Electricity Works.

(Continued on page 521.)

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L. C. C. AND TRAMWAYS.

We do not remember having advocated the municipalisation of tramways, nor do we see any more reason for such a course than for municipalising bakeries, booteries, and groceries. History and experience tend to cause hesitation in returning to the pre-civilised state, when a fatherly chief dictated to the tribe the position of each individual member. But whether we like it or not, whether we argue against it or not, the hard fact remains that some municipal authorities have obtained control of tramways and others are seeking to obtain such control. The London County Council has entered upon this course, and seems inclined to continue therein. It was Pope, in his "Essay on Man," who assisted to indoctrinate us with the idea that "what is, is right"; so we presume that if the London County Council does this thing it must be right. The ratepayers acquiesce, and there is an end of the matter. It is not many years since the London County Council started to do its own work, organised a Works Department, and was going to show the world at large, and the London ratepayers in particular, how cheaply work could be done and how well. Lately funny rumours have been heard that in this direction "all is not well," and sanguine individuals go so far as to prophesy that the Works Department will gradually dwindle into insignificance. But the ratepayers will have to pay the piper all the same. All that we can say will not stop the London County Council scheme, because that scheme is based, not upon financial or business considerations, but upon the popularising of its members and the securing of votes. Men are but human, and if desirous of place, power, and pelf do not look too closely into money matters which appeal most closely to other folk's pockets. Assuming, however, that municipalisation of tramways is the correct course to follow, there remains subsidiary questions to be decided. So far as we are concerned, one only is of interest—Is it advantageous to work tramways electrically? We have no hesitation in answering this question in the affirmative. Elsewhere we give a letter of Mr. J. A. Baker, a member of the Highways Committee of the London County Council, to the chairman, dealing more particularly with the question of electric traction. Mr. Baker is altogether in favour of such working, although his conclusions are derived from sources that are under somewhat different conditions to those which rule in the Metropolis. We have often pointed out that the so-called American tramlines are in reality light railways, and must be classified as such in all comparisons. Just as it is more economical to generate steam with a large plant than with a small plant, so we should imagine it must always be more economical to run an ordinary railway than a light railway, and a light railway than a tramway. We cannot therefore accept all figures put before us in favour of substituting one system over another. The figures are not fair, and we have no desire to carry our contention by means of incorrect figures. The London County Council, as Mr. Baker points out, has considered one part of the question only, and has come to a conclusion upon "what is" without con-

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sidering what may be or what ought to be. That increased traffic always comes with better service and better accommodation is certain, though that increase may not be 100 per cent., as Lord Mountmorres stated, unless a large part is due to increase of population upon the route. We certainly have a decided opinion that the dual system with accumulators on the car so successfully tried in Germany ought to be thoroughly investigated here. The car is then run from the trolley in the suburbs and is self-propelling in the more crowded streets. The charge is given to the accumulators when running on the trolley. This question of electrical traction has not yet been fairly considered—that is, almost all the information is derived either from expressed opponents or from those engaged in promoting schemes. The real truth is somewhere between the views such men express, and we think lies nearer to the claims of those engaged on the work than to those of the opponents.

CROYDON ELECTRICITY WORKS.

(Continued from page 519.)

It will be seen that both the laps, as well as the rivet heads, are removed from the line of draught, and consequently escape the scouring action and intense heat of the gases as they pass along the flue. This type of boiler (shown out of its seating in Fig. 6) was introduced by Mr. James Paxman some 35 years ago, and is of the internally-fired type. The furnace terminates in a brick combustion chamber, which becomes very greatly heated, more uniform temperature, and the result is an absence of leakage set up from undue expansion and contraction in the flue, shell, or tubes. The tubes are made $\frac{1}{4}$in. larger at the smoke-box end, so that they can be easily removed. The cleaning of tubes and flues is entirely effected from the front of the boiler.

We are informed by the makers that these boilers are best worked with a draught equal to not less than $\frac{5}{8}$in. of water (though $\frac{3}{4}$in. is preferable), and they are most economical when being worked at about 5lb. evaporation per square foot of heating surface, and for this purpose the draught should be not less than above stated. In actual daily work these boilers have been found to evaporate 12·2lb. of water per pound of best Welsh coal from feed at 212deg. F.

Feeding Arrangement.

The boiler can be fed by two Worthington feed-pumps, either of which are capable of supplying feed for the full load of the present plant. These pumps are arranged to feed either direct from the supply tank or by passing the feed-water through the economiser. A Kennedy water-meter is provided to check the quantity of feed-water used. The Green's economiser supplied to Croydon is one of this firm's most improved design, consisting of 128 pipes, arranged in two groups, each being connected together by copper expansion elbows. The economiser is made for high pressure, and fitted with Green's patent internal lids. All the most modern improvements that have so far been devised are also included in this apparatus. The scraper gearing is driven at present by a small horizontal high-speed engine, which is attached to the gearing frame of the economiser, but we understand that an electric motor will shortly be substituted.

Steam and Exhaust Pipes.

The arrangements of this part of the work can be seen in Figs. 2 and 3. The steam-pipes generally are of lap-welded mild steel, with cast-iron T-pieces and copper bends.

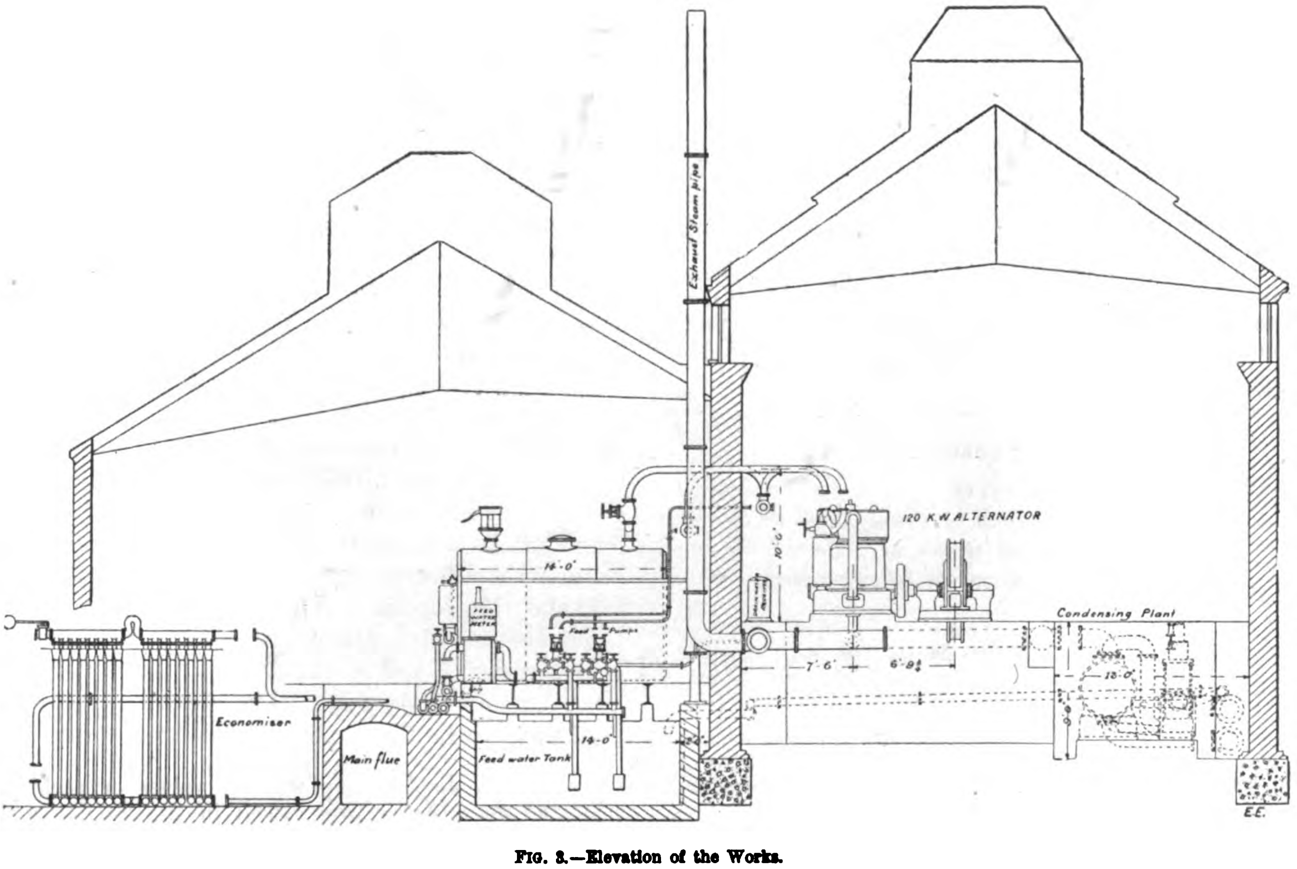

FIG. 3.—Elevation of the Works.

and tends to a perfect combustion. There is an absence of smoke which enables the surfaces to be kept clean, and they are able to absorb the heat, which is cut up in a similar way to that passing through the tubes of locomotive boilers. In addition to this the gases pass into a smoke-box, and are directed round the external surface of the boiler. This is a great advantage, as the boiler is kept at a Two steam-mains are provided, one in the boiler-room and one in the engine-room. These mains are 6in. diameter. Connections are made from each boiler and engine into each main. There are no valves in the mains themselves, but only in the junctions to the boilers and engines respectively. The Y-piece on the boilers, with two valves, can be seen in Fig. 4, and those on the engines in Fig. 7

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With this arrangement one half of the engines can be supplied by steam from each main if desired, and the number of valves usually found in the steam-ring is avoided. It will also be noticed that all the valves are used regularly, and hence are more likely to keep in good order than those which are only closed in cases of emergency. The connections from the boilers to the mains are 5in. diameter, while the copper bends to the engines are 4in. diameter. as shown in the ground plan and elevation of the station. The circulating water will be obtained from the Wandle Park Lake. The 16in. cast-iron circulating pipes for conveying the water have been fixed by the Corporation.

The Engines.

Messrs. G. E. Belliss and Co., of Birmingham, were the contractors for the engines, and have supplied and fixed

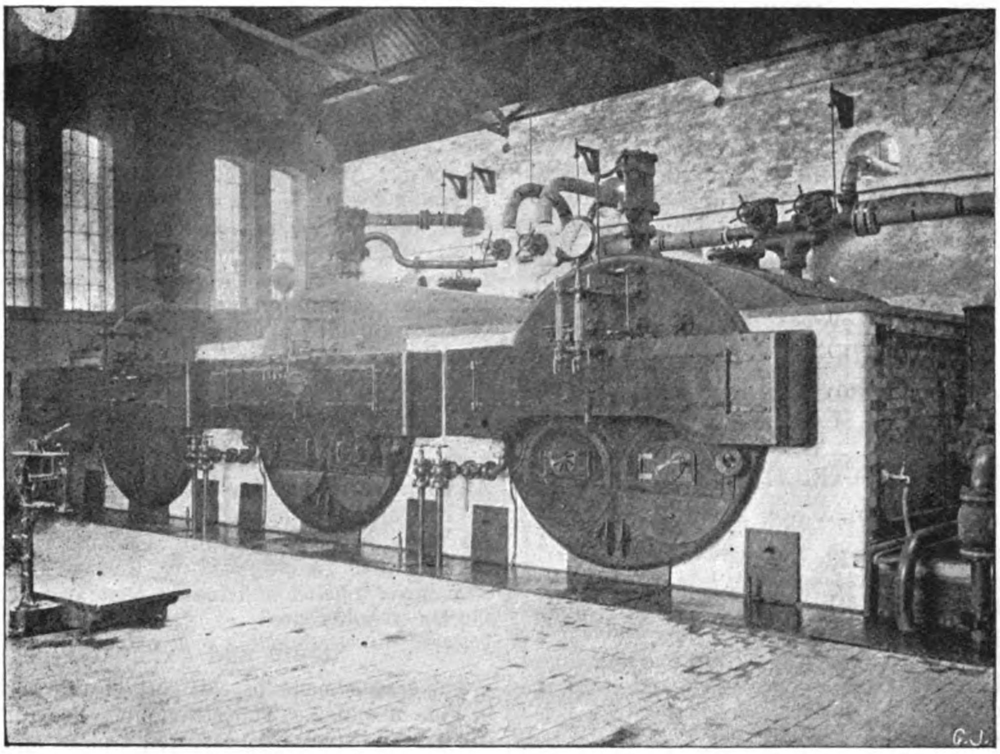

FIG. 4.—General View of Boiler-House at Croydon.

three of their two-crank compound self-lubricating type. In this station the engine and alternator are placed independently of each other on the concrete foundation, and are rigidly coupled together. Thus it is the stability of the concrete foundations on which they depend for the correct alignment of the engine and dynamo shafts. The engines are of the standard E.C. 10 size, the cylinders being 12in. and 20in. diameter respectively, with 9½in. stroke. They are designed to give off 240 i.h.p. when running at a speed of 360 revolutions with steam pressure at the engine steam stop valve under 150lb. per square inch, and with the vacuum equivalent to 25in. of mercury. The lubrication is a special feature in these engines. The oil is supplied

The steam-pipes are supported by rods from brackets fixed to the walls (Fig. 7), the joints in these rods allowing of small lateral movement in either direction.

The exhaust-pipes are carried in channels left round the foundations. The exhaust-main is of cast iron 12in. diameter, with 7in. connections to the engines. The arrangement of these pipes can be seen in the general plan. The exhaust to atmosphere is taken up in the corner of the boiler-house, and rises in four sections to a height of 40ft. The whole of this work was erected by the British Thomson-Houston Company. The surface condenser was supplied by Messrs. Browett, Lindley, and Co., of Patricroft, Manchester. It consists of a vertical tandem compound engine coupled by

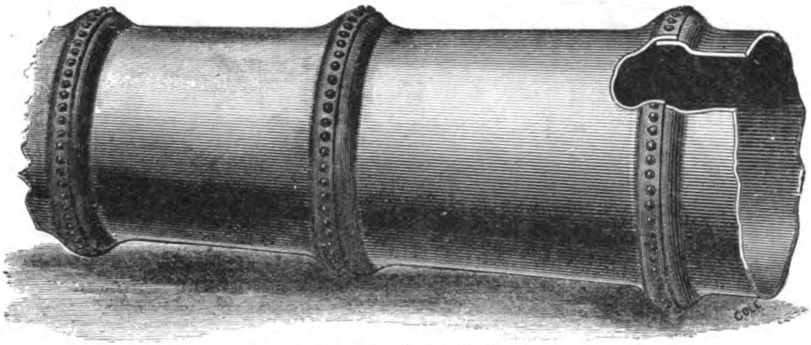

FIG. 5.—Tube of Economic Boiler.

spur gearing to air and circulating pumps, and working in connection with a surface condenser. The principal dimensions of this plant are as follows: steam-cylinders, 5½in. and 9½in. diameter by 8in. stroke; air-pump cylinders, 9½in. diameter by 10in. stroke; circulating-pump cylinders, 17in. diameter by 10in. stroke; the ratio of the gearing between engine and pump shaft is 2¼ to 1; the cooling surface in the condenser, comprising some 800 square feet, consists of solid-drawn brass tubes ¾in. external diameter, the circulating water being arranged to pass through the tubes. This plant is placed below the engine-room floor, by means of a simple pump, without valves or packing, working off the eccentric from a well in the framing, and discharging under pressure through oil channels into all working parts. The makers claim that the double action of the engine permits the film of oil at this pressure to get thoroughly between the working journals and brasses, keeping them apart and preventing any wear or chance of knocking with any load. The engines were tested at the makers' works to their full load on a water brake under the specification conditions, the trial being supervised by Prof. Kennedy. The water discharged from the condenser

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was weighed, with a result that at full load the consumption was found to be 17·9lb. per brake horse-power, a result well within the guarantee. The engines were also

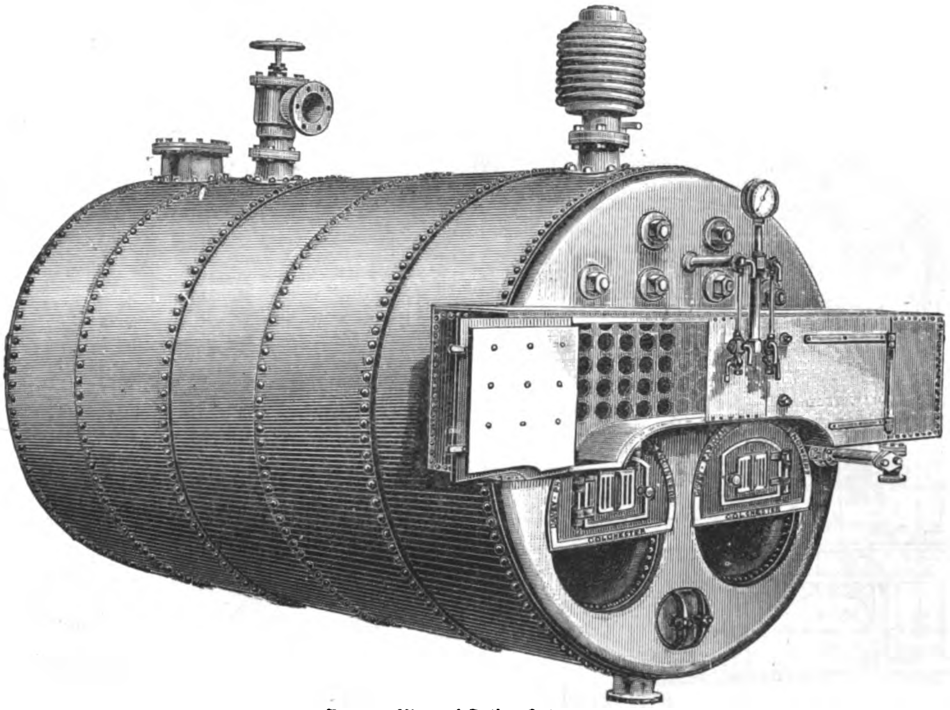

FIG. 6.—View of Boiler Out of Seating.

run for a period of six hours continuously at the full power to the inspecting engineer's satisfaction.

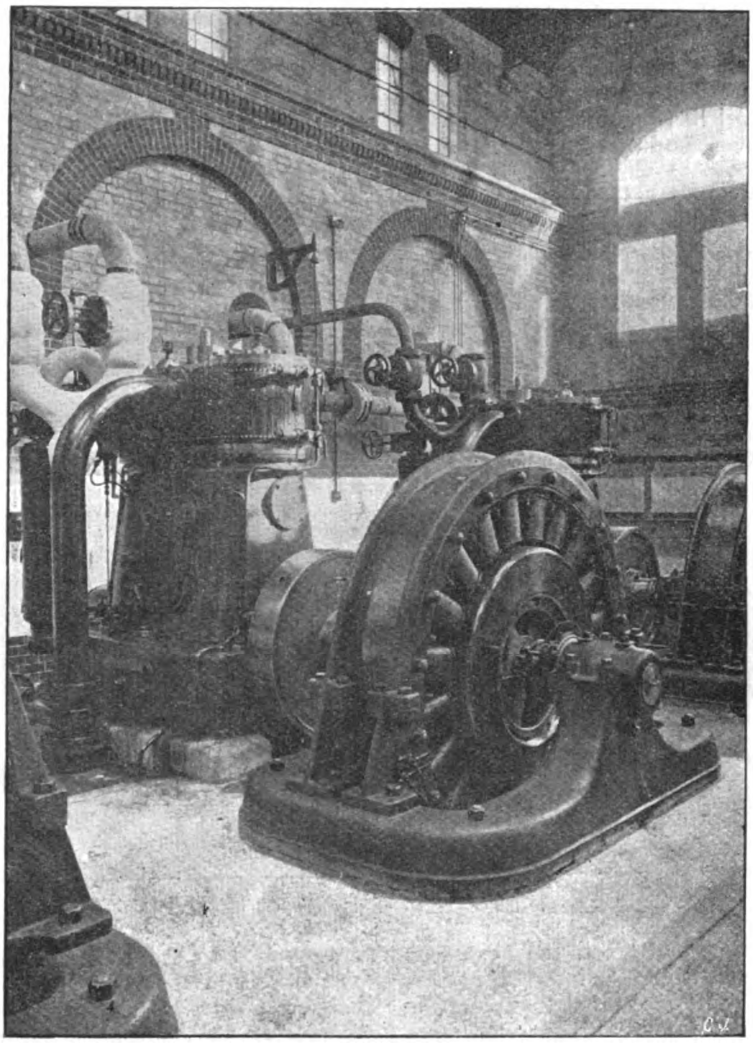

FIG. 7.—View of Steam Alternator.

Alternators.

The alternators coupled to the above engines were supplied by the British Thomson - Houston Company themselves. They are of American manufacture, and are each capable of giving an output of 120 kilowatts at 360 revolutions per minute. The voltage can be varied between 2,000 and 2,200 volts. The frequency of these machines is about 60 per second. A general view of one of these alternators is given in Fig. 7, and an elevation in Fig. 8. They have 20 poles each. The field-magnet cores and yokes are built up of laminated stampings clamped between

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heavy cast-iron rings. The field coils are wound on formers, and after being slipped on are held in position by two bolts, one at either side. The armature core is also built up of laminated plates grooved to receive the coils. These grooves or slots are not placed symmetrically round the armature. Each pair of grooves, holding one complete coil, have their edges parallel to each other and to the radius through the centre of the coil. This allows of the coil, which is fully insulated, and thus complete in itself, to be easily slipped into position. As the sections at the bottom of adjacent teeth formed by grooves thus made must be equal, it follows that the surface of the core is not divided symmetrically. The distance between the inner edges of the two grooves holding one armature coil is less than that between the other edges of the grooves and the next slots on either sides. When the coils have been inserted, wooden wedges are driven in, keying into recesses at the top of the slots, and securely holding the coils. Brass end rings prevent the wedges from being displaced. The lubrication of these alternators is effected on the ring system, but the rings are split and screwed together, which greatly facilitates erection or removal.

The excitation of these alternators is supplied in a somewhat novel way, as there are no direct-driven exciters in the station. A motor generator (Fig. 9) is used to convert from alternating into direct current and to charge the accumulators, which will always be used for excitation at times of heavy load. The capacity of these cells is sufficient to keep the station going for at least two full working days. The alternating motor is an eight-pole one, running at a speed of 900 revolutions per minute. It is capable of taking some 30 kilowatts without undue heating. The field-magnet cores are laminated, and are cast into the yokes. The direct-current machine is one of the American four-pole toothed-core type with carbon brushes. This dynamo charges the accumulators, which were supplied by the Electrical Power Storage Company. Some 60 cells of the 31-L type are provided in lead boxes. These are capable of discharging at 100 amperes for five hours, or at 250 amperes for half an hour. The requirement for excitation is, however, of the nature of a small discharge for a still longer period. The cells are placed on substantial wood shelves attached to cast-iron supports. Every convenience is supplied for examining the cells and

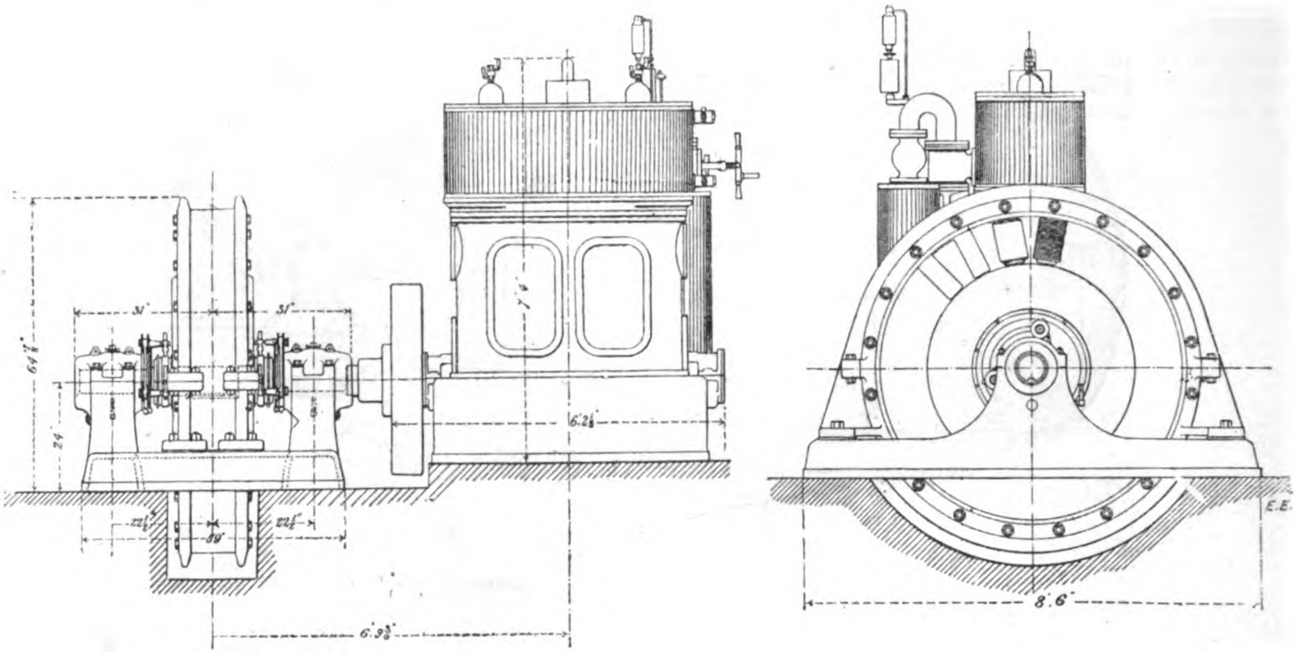

FIG. 8.—Elevation of 240-I.H.P. Engine and Alternator.

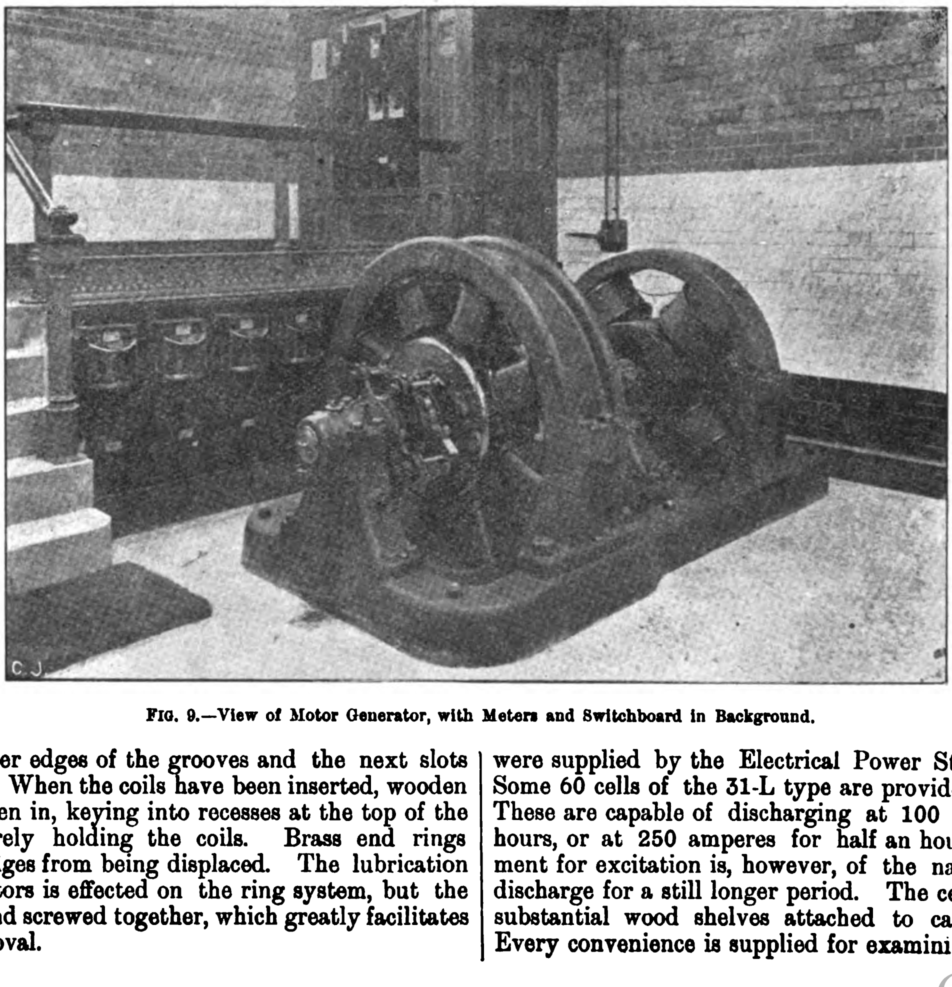

FIG. 9.—View of Motor Generator, with Meters and Switchboard in Background.

take records of density, voltage, etc. The whole of the switch gear for the batteries, and also a small motor generator for milking-up weak cells, were supplied by Messrs. J. H. Holmes and Co., of Newcastle-on-Tyne. This motor generator (Fig. 10) transforms down to about three volts, giving 80 amperes to any cell that may require special charging. The leads for this purposes are encased in rubber hose pipe to prevent the acid fumes from injuring the insulation. A special feature on the switchboards is the Holmes starting and stopping switch. These are made on the ratchet principle, the handle of the switch acting as the pawl. The forward movement of the handle shifts the contact

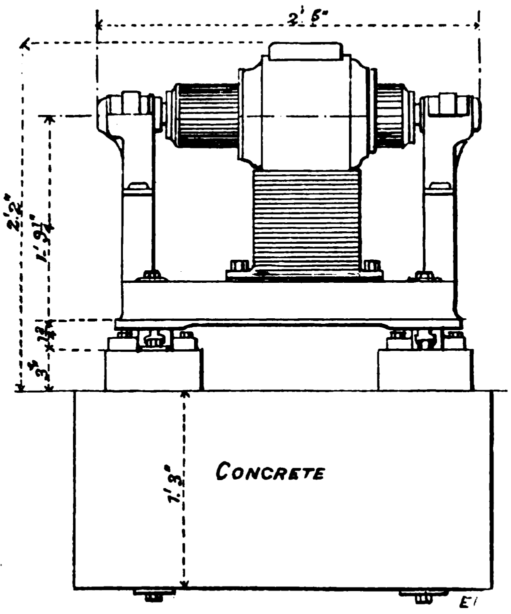

FIG. 10.—Elevation of Holmes' Motor Generator.

bar forward by one step, and the handle has to return to its position of rest before the contact bar can be again moved. In this way the switching on is effected by a kind of pumping process, and the motor resistance cannot be thrown out of circuit rapidly. The connections to this switch are such that on breaking the connection with the main, the shunt circuit remains connected to the armature and discharges its extra current through it. On starting up again, the first movement of the lever disconnects from the armature, the next connects the shunt to the main, and the third movement connects the armature to the main through

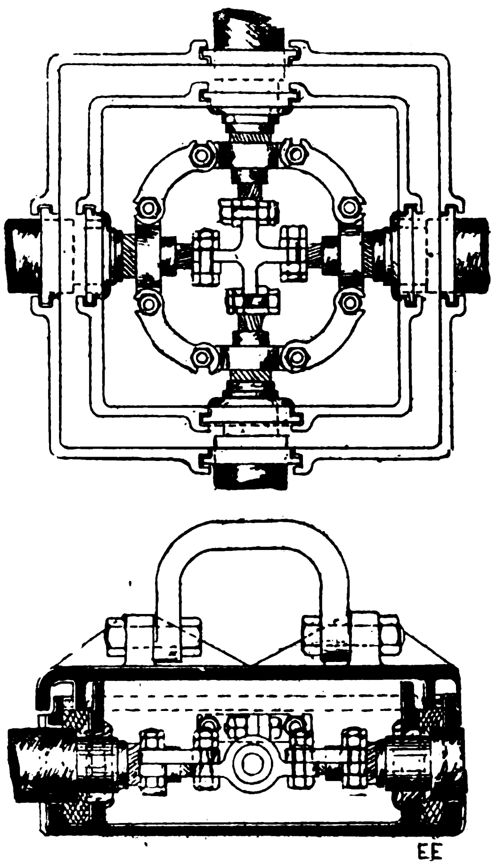

FIG. 12.—Four-Way Network Box.

resistance, which is cut out step by step. These switches will be a most valuable adjunct to all motor equipment where unskilled labour is employed, as they will protect the motor from excessive currents.

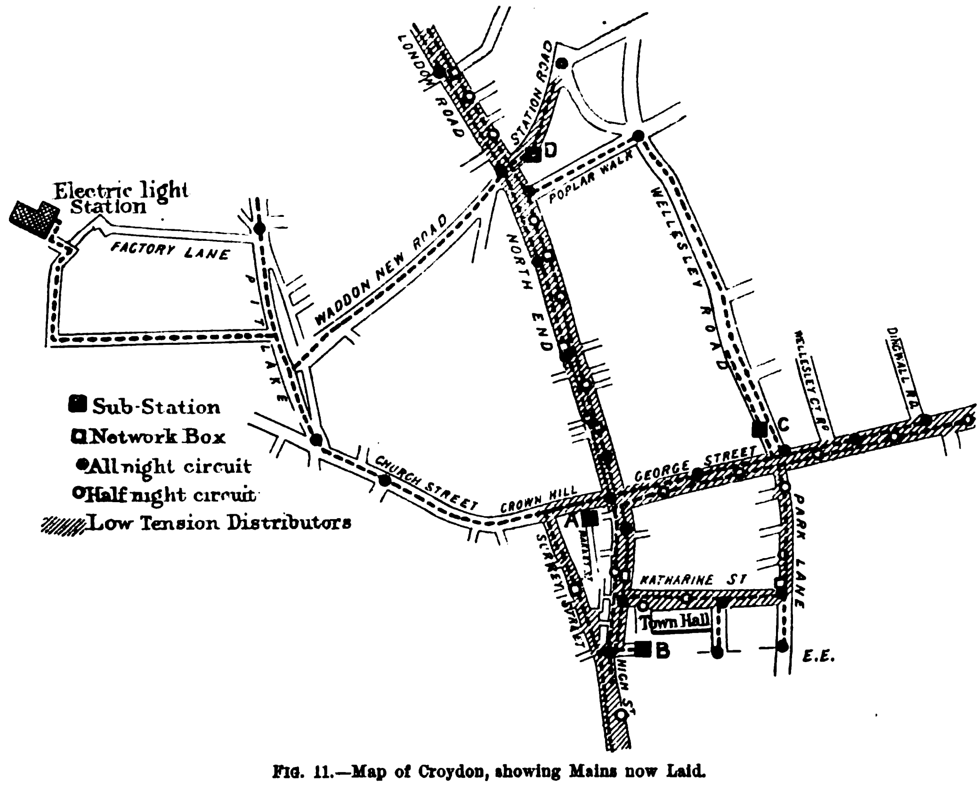

FIG. 11.—Map of Croydon, showing Mains now Laid.

The main switchboard, the rectifiers, and the rectifier switchboard were supplied by Messrs. S. Z. de Ferranti and Co. The main switchboard is of their standard single-pole type, but two omnibus bars are provided. Any alternator or feeder can be switched on to either bar, so that if required

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the load can be supplied in two sections. The rectifiers were not in place when we visited the station, but we understand that the supply of the street-lighting will be commenced from the opening ceremony to-day. The arc lamps for this work are of the usual Thomson-Houston type.

Mains.

The whole of the contract for the underground mains has been carried out by Callender's Cable and Construction Company, Limited, of 90, Cannon-street, London, E.C., who have both supplied and laid the cables, and have carried

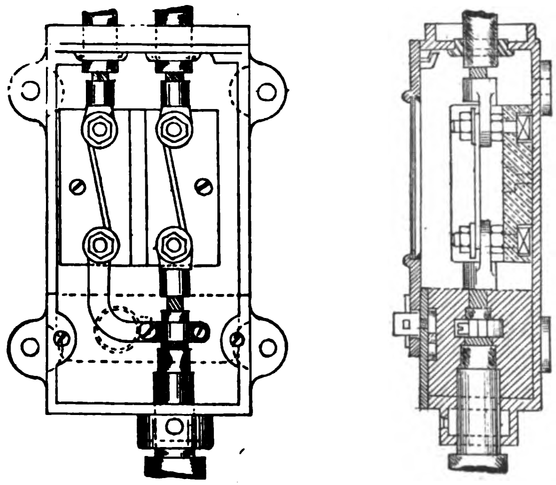

Fig. 13.—Reid House-Connection Box.

out all the excavation of the necessary trenches. As mentioned above, the supply is on the high-tension alternating-current system, being supplied to the feeders at a pressure of 2,000 volts, and then transformed down at the various sub-stations to a distributing pressure of 200 volts.

From the generating station (Fig. 11) three main feeders, of the concentric lead-covered, iron-armoured type, are run. The first is of ·09 square inch sectional area, and goes to

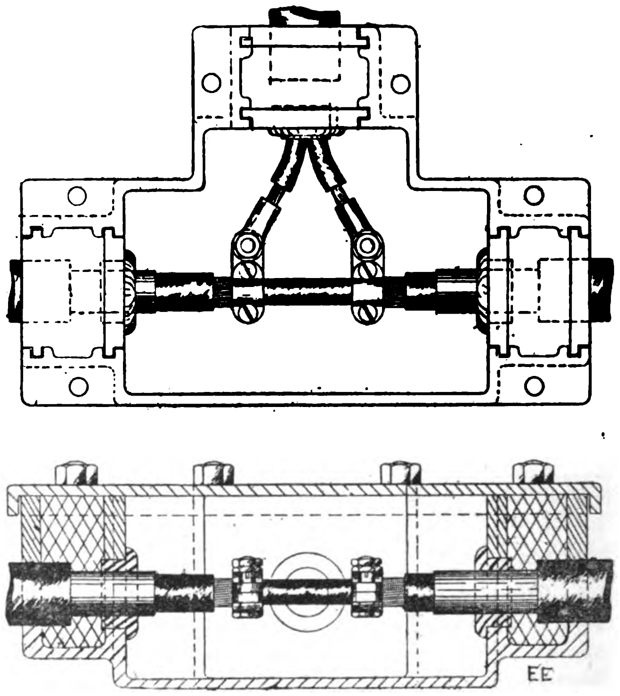

Fig. 14.—Arc Lighting Street Junction Box.

the sub-station A, in Market-street, a distance, of 1,200 yards. The second is ·08 square inch in section and connects to the sub-station D in Station-road, a distance of 1,100 yards. The third is ·07 square inch in section, and goes to the sub-station B in Mint-walk, a distance of

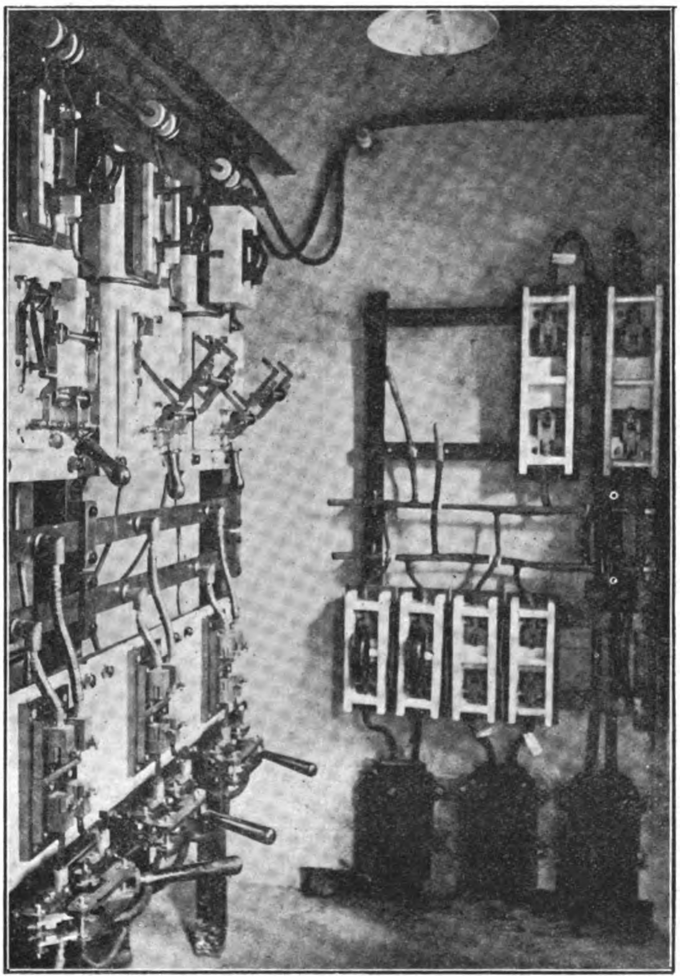

Fig. 15.—Sub-station Switch Gear.

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1,550 yards. A branch feeder of ·04 square inch section is run from sub-station A to sub-station C in Wellesley-road, 360 yards in length. In addition to these feeders, the sub-stations are inter-connected by means of a ring main ·025 square inch, running thus: D to A, A to B, B to C, and it is proposed shortly to connect C and D *viâ* Wellesley-road, St. James-road, and Oakfield-road, taking in a new sub-station, E, in St. James-road. At present 2,500 yards of this cable have been laid. Under ordinary working conditions these inter-connecting ring mains will not be used, but they will be convenient as a stand-by. In the sub-stations the concentric cables are led into dividing boxes bolted on to the wall (Fig. 14), and from these dividing boxes two single conductor cables of vulcanised bitumen are led to the station high-tension fuses. The dividing boxes are filled up with compound, specially prepared by the Callender Company, so as to effectually seal the cable ends.

The high-tension feeder cables are all of Callender's well-known concentric type. Each of the conductors is insulated with a dielectric of bitumenised fibre, and the outer dielectric is encased in a solid lead tube, the lead being put on under great hydraulic pressure. The cable is then served with yarn thoroughly compounded, and finally protected by an armouring of two steel tapes or ribbons of carefully selected mild steel. The cable is finally served with an outer covering of jute yarn and finished with hard compound. These cables are laid direct on the ground, and about 3in. over them are placed tarred boards, 6in. by ⅝in., so as to give an indication of the presence of the mains to anyone opening the streets at a future date. From the sub-stations a network of low-pressure concentric cables, similar in type to but less heavily insulated than the feeders, is carried through the principal streets of the town, and distribution is made on the two-wire system at 200 volts. The section of the low-tension cables is ·10 square inch, with the exception of two short lengths of ·25 square inch leading from sub-station A to the junction of North End and High-street.

In ordinary working the different sections of the network leading from the various sub-stations will not be connected together, each sub-station distributing current to its own separate section of the network. Network boxes, however (Fig. 12), are provided at various points marked on the plan so that the separate sections can be connected together. About 600 yards of distributing main have at present been laid. These network boxes, placed in brick pits measuring 24in. by 24in. inside, are set in cement, and provided with cast-iron frames and surface covers. The network boxes themselves are placed on brick piers inside the pit, the piers being 1ft. high. The brick pit is drained by a 2in. pipe. The service cables used are of a similar type to that of the distributors, the sectional areas being ·022 square inch and ·064 square inch. These run from the mains direct to the consumers' premises, where they terminate in Reid's patent cut-out boxes (Fig. 13). This type of box acts not only as a cut-out, but as a permanent seal for the cable ends, preventing any injury to the cable even in damp cellars.

In addition to the supply for private lighting cables, two arc lighting circuits for public lighting have been run from the generating station through the busy thoroughfares of the town. These cables are manufactured in precisely the same way as those for the feeders, and are laid direct in the ground, then covered with tarred boards similar to the feeders. In all 7,500 yards of arc cables have been laid. The arc lamp services consist of a twin cable of vulcanised bitumen, lead sheathed and armoured, tapped off the outer conductor of the concentric main by means of a special branch box designed by the Callenders Company (Fig. 14), and leading to the switch terminals in the base of the lamp-post. At present there are 40 lamps on the two circuits, and it is intended that one circuit shall be run all night and that the other shall be shut down at midnight. The positions of the arc lamp-posts are shown on the accompanying plan.

Sub-Station Equipment.

Of the four sub-stations now built, two are below ground and two above. The view of the switch gear shown in Fig. 15 was taken in sub-station B. From it the general connections can be followed. The concentric feeders enter the station at the floor level, and in this case there is one main feeder and two smaller feeders linked from other sub-stations. From the Reid's junction box the wires are led through high-tension fuses to the high-tension omnibus cables. The connections are made from these to the transformers by means of the double shutter switch seen to the left of the illustration. Switches and fuses are also placed lower down on the framework, by which the secondaries of the transformers are connected to the low-pressure omnibus bars. The fuses in the low-tension feeders cannot be seen in the illustration.

The erection of the whole of the work has been superintended by Mr. A. Fell on behalf of the British Thomson-Houston Company. This gentleman previously had charge of the contracts carried out for the City of London Electric Lighting Company, and is to be congratulated on the general finish of the station.

L. C. C. AND TRAMWAYS.

[The following communication by Mr. J. Allen Baker, a member of the Highways Committee of the London County Council, to the chairman will be of interest, as showing that the subject of electric traction is exercising the minds of some members of the Council, and that they are desirous of seeing it fairly tried.—Ed. *E. E.*]

Sir,—I regret again to trouble you with another communication on the above subject, but considering its vast importance, and the evident interest taken in my previous letter by my fellow councillors, I am emboldened to add this further.

You will remember that on my motion in Council on June 23 last the recommendation of the Highways Committee was referred back "with instructions to report, for the purpose of comparison, as to the probable profit to the ratepayers if the Council itself worked such portions of the northern system of tramways as will be within its control after 1898, information being given upon the basis of horse traction and also electric traction or other approved mechanical means."

The present report of the Highways Committee, which is now before the Council, you will observe, deals with the first portion of this reference, but not with the second, and I venture to believe that the Council was especially interested in the results of *mechanical traction* as in use in various cities on the Continent of Europe, in America, and also in some places in England, and was particularly desirous of having an estimate of the probable results for London if such were adapted to our tramways. I especially urged in the Highways Committee again, that before the present report was sent to the Council, such information should be obtained, and was prepared myself to place before the committee much valuable information on the subject, but by a majority of one the carrying out of this portion of the Council's instruction to the Highways Committee was defeated.

During the recess I have given considerable time and study to this subject, and have myself visited numbers of places where mechanical traction or municipal working of tramways is in vogue—notably Blackpool, Huddersfield, Leeds, Glasgow, Edinburgh, etc.—and have had reports and communications from numerous other places both in this country and in America. As a result, I am more than ever confident that we will not obtain proper value for our property either in the sense of giving an efficient service to the travelling public of London or an adequate profit to the ratepayers of London until we adopt a suitable system of electric traction and have the full benefit of the very great advantages that are to be derived therefrom.

I am aware of the provisions in the proposed lease to the companies as the Council's right of insisting upon the adoption of electric traction, but I venture to say that "to lay down and equip about a mile" of electric railway could in no sense give a satisfactory test, either of efficiency or economy, and no trial could be satisfactory in proving actual results except the equipment of a complete line, in which the increase of traffic would be demonstrated.

Further, the provisions of clauses *A*, *B*, *and C* are not such as in my opinion will give the Council anything like the benefit they should derive from the adoption of improved traction, while the whole proposal is fraught with provisions that would be extremely difficult to carry out in actual working.

I am convinced, however, that the results already obtained in other large cities in which similar conditions prevail to those in London, are a sufficient guarantee of success to justify a complete line or system being laid down in London. The engineer has also stated, in a report to the Highways Committee on October 25, 1896: "That it is perfectly practicable

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to work the tramways in London by means of electricity conveyed either overhead or underground."

I will further add that I am certain there is no city in the world that more greatly needs these improvements, nor in which they would prove more profitable; therefore if in cities on the Continent, in America, and in provincial towns in the United Kingdom, the adoption of electric traction in substitution for horse traction effects an economy in working of from 25 per cent. and upwards, and secures an increase of traffic of from 25 to 100 per cent., such results may also be *confidently anticipated* for London.

I believe there are *no* exceptions to this rule in any country where electric traction has been adopted, and with the immense travelling population of London and the necessity for a frequent and efficient service of tramways in all parts of the Metropolis, the possibilities are enormous.

As an illustration of the above facts, let me instance the case of the new electric line installed by the Dublin Southern District Tramway Company. The line runs from Dublin to Blackrock, Kingstown, and Dalkey. In the first year of working the Southern system (then in three sections with horse traction), the traffic was carried on upon an expenditure of 136 per cent. of the gross revenue! The lines were afterwards united, and the year before its conversion to electric traction earned 2½ per cent. on capital. In May, 1896, the electric line was opened and at once became a marked success. Notwithstanding the fact that the fares are only half what they were formerly under horse traction, the gross takings are five times greater, and within two months of the new line starting operations the 7¾ miles of a double line with electrical equipment was sold to the Dublin United Company for the enormous sum of £273,000. (I estimate the entire cost of installing the line to have been but little, if any, above one-third this sum.) And the line is now reported as "paying well" on this huge capital.

The Dublin United Company are now proceeding to convert the Clontarf line of horse tramway to electric, and are also seeking parliamentary powers for the conversion of the whole 32 miles in the city. My informant adds: "This is very much the outcome of a visit of inspection to various cities on the Continent, and also to America, made by three of the directors and the manager. Their action may have been hastened by the enterprise of the Dublin Southern District Tramways Company."

I give the following extracts from a letter just received from the Mayor of Springfield, Mass.: "The introduction of the electric system in Springfield has increased our service from about eight miles of track to 60 miles. This has connected all suburban towns, to the very great benefit of our business men. It has increased our taxable property tremendously, and given our workmen much better homes.

"No one factor has done so much for the general welfare of our city as the change from horse power to electricity. The advantage to the road has been that it has lessened the cost of operating per car mile considerably, of course more in some places than others, but I should consider 40 per cent. a safe estimate for the average decrease in this State.

"The rapid transit has very largely increased the traffic, and the pleasure riding, during the summer months, is enormous. I should consider 50 per cent. a very moderate estimate of the increased traffic occasioned by the change of power.

"The longest ride for one fare (five cents) is about 15 miles."

I know this town and its electric system well. This is but one of the *hundreds* of like cases that can be produced from every part of the United States and Canada.

Coming nearer home, the town of Leeds has had a system of partly horse and partly steam traction worked by the Corporation itself since February, 1894. A trial line of electric traction has been installed, with the result that the whole of the lines in the town, amounting to about 17 miles of double line, are about to be installed. The Corporation engineer, in carefully prepared estimates, shows that the advantage to the Corporation by reason of the change will be over £27,000 per annum.

The improvement in the earnings, even under the present system of traction, has been remarkable since the Corporation itself has worked the lines, like experiences being also shown in Glasgow, Sheffield, and other towns where municipal working prevails. The hours and conditions of labour in all these cities have also been improved.

In Sheffield, during 14 weeks of municipal working, with a reduction of fares and shorter hours of labour, the traffic receipts have increased over £112 per week on their nine miles of double lines. So successful has the Corporation venture been that they have decided to immediately add 22 miles of lines, and are now seeking information by deputations visiting the Continent and America with a view of installing electrical traction.

The experience is universal in favour of municipal as *versus* company working of tramways, and I maintain that the most important point of all in connection with the present proposals of the Highways Committee is the fact that if carried we would tie up for 14 years the possibility of obtaining a united tramway system for London.

The present proposal deals with two companies only. There are 10 left? With separate working are divided interests, unnecessary working expenses, and the absolute impossibility of securing for London *the* tramway system that it so greatly needs. This was most ably put by Viscount Mountmorres in the admirable speech which he made during the tramways debate on June 23, when the necessity of a much more efficient and extended tramway service for the benefit of the whole of London's millions was forcibly pointed out.

In an article in the *Times* on Monday, April 27, appeared the following: "The present arrangements in connection with the tramways of London are very unsatisfactory. These arrangements always left much to be desired, but it is only within the last few years that the condition of affairs has become so bad that amendment is imperatively demanded. The chief evil always was that the area covered by the tramways was in the hand of too many different companies, only two, or at most three, of which were really prosperous and consequently in a position to do their work well. Even if all the companies had been successful financially the existence of so many separate centres of administration would have been an evil. An even greater evil is the fact that at present the tramways of the Metropolis consist of two entirely disconnected areas—one to the north, the other to the south of the Thames. The want of a coherent and well-organised system of working has become plainly manifest now that portions of the lines hitherto under the control of the companies have fallen through lapse of time into the hands of the London County Council, and that other portions are on the point of doing so. . . . The working and administration of tramways broken up into sections under different authorities must obviously be wasteful and inefficient. . . . There can be little doubt that sooner or later electric traction will have to be adopted for London, as it has been for many other cities, especially in the United States. Cars driven electrically occupy less space than horse cars; the streets in which they run are cleaner; speed can on the average be greater; and there will consequently be less hindrance to other traffic. . . . It seems to us that any scheme by which the present piecemeal administration would be perpetuated ought to be rejected!"

In 1901 the whole of the lines north of the Thames, except a few unimportant fringes, will be in the possession of the Council, and also about 20 miles of the southern system. Within five years, therefore, the trunk lines on both sides of the water will be available for the Council to work as a united system.

The case is therefore overwhelming in favour of the improvements in service and traction for London, and nothing could be more favourable for the Council than to itself acquire and work the various lines as they fall in, and gradually adapt the most satisfactory mode of traction. This would give the needed experience for the undertaking, and be more practical and satisfactory than at the end of 14 years having the whole of the old lines taken over and operated without previous practical experience. The interval would be useful in enabling the Council to gain the needful experience and study both the requirements of the travelling public and the profit to the ratepayers.

The number of car miles run by the North Metropolitan and London Street Companies during the last year is 12,346,474.

The cost of working per car mile is about 10d., amounting to (approximately) £514,436.

The cost of working the conduit system line at Budapest is 5d. per car mile, and a further liberal estimate for interest, depreciation, and sinking fund would be 2d. per car mile, say, 7d. in all as an outside cost of working per car mile, including repayment of capital, repairs, and maintenance of lines. This would give 3d. per car mile of clear profit on the introduction of the conduit system for the North London lines, and would mean an extra annual income or profit (above the earnings of the present horse traction) of £154,329 per annum. (The difference of 1d. per car mile in cost of working amounts to over £51,000 per annum.)

The conditions of London as compared with Budapest are more favourable for mechanical traction, as there would be needed a much more frequent service, and as it has an enormously greater travelling public, this proportionately decreases the working cost, and I think it certain that with the still later improvements in underground traction than are now in use at Budapest the working per car mile for London would be well within the above figure.

The passengers carried per car mile run in Budapest are	8·25
Ditto, ditto, by the North Metropolitan year ending June 30, 1896	10·66
Ditto, ditto, for the London Street	10·61
The receipts per car mile are, in Budapest	11·1d.
By the North Metropolitan line (half-year ending June 30, 1896)	12·39d.
Ditto, ditto, London Street	12·57d.

This is entirely in favour of economy in working and profit for London as compared to Budapest.

Add to this the certain increase of traffic, which upon a

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moderate estimate might be reckoned at 25 per cent. (the increase in the gross takings of the above two companies even with horse traction during the past year amounts to £54,915), and it will be seen that to tie our hands and complete the present arrangement with the companies would be a suicidal policy for the Council to pursue, and directly opposed to the best interests of the London ratepayer.

I would plead one further and still greater consideration—viz., the claims of the millions whom we represent, to whose health and well-being an improved means of street transit will manifestly be a consideration of the first importance.

The fact that the 131,506,427 journeys during the past year made on these two lines alone could be lessened in expenditure of time, fatigue, and possibly in cost also, thus giving to this vast number an increase of leisure, strength, and money for self-improvement, should make us hesitate before we hastily settle a question of such magnitude.

Trusting I have not trespassed on your kind indulgence, I remain, dear Sir, yours faithfully, J. ALLEN BAKER.

PHYSICAL SOCIETY.

There was a special general meeting of this society on October 30, Captain Abney, president, in the chair.

The **Secretary** having read a summary of the replies sent by members to a circular which had been addressed to them during the last session, a series of resolutions drawn up by the council bearing on the points raised by this circular were adopted. The chief of these resolutions were to the following effect: (1) That the subscription to the society be raised to £2. 2s.; (2) that present life members be invited to voluntarily subscribe £1. 1s. annually to the funds of the society or to compound for this annual contribution; (3) that a guarantee fund be instituted; (4) that in future members of the society be styled "Fellows of the Physical Society of London"

In the course of the discussion on these resolutions, the **President, Secretary,** and **Treasurer** gave an account of the financial position of the society, and explained that at present each member receives from the society in the shape of *Proceedings* and abstracts printed matter which costs the society more than the amount of the annual subscription.

The ordinary general meeting was then held. A letter was read from **Lord Kelvin** thanking the society for the address which the president on their behalf had recently presented to him.

Prof. W. Stroud read a paper by himself and Mr. J. B. Henderson on **"A Satisfactory Method of Measuring Electrolytic Conductivity by Means of Continuous Currents."** The method consists in placing a balancing electrolytic cell in the arm of the Wheatstone's bridge adjacent to the arm containing the chief electrolytic cell, so that the E.M.F.'s of polarisation in the two cells neutralise each other's effect on the galvanometer. The authors find that if the resistances of the arms of the bridge are high (20,000 ohms), and if an E.M.F. of about 30 volts is used in the battery circuit, then the resistance of a solution (of potassium chlorate in their experiments) can be determined to within about one part in 2,000. With a d'Arsonval galvanometer the balancing cell is so efficacious that it is impossible to tell that it is not a metallic resistance that is being measured.

Prof. Perry asked if the authors had tested whether the difference in resistance of the two cells was proportional to the difference in length of the liquid columns.

Mr. Appleyard said he had found that the resistance of an electrolyte appeared to vary, because in the ordinary arrangement the cell was short circuited through the arms of the bridge. He suggested as a remedy the making and breaking of the circuit by a special key, so arranged that except when taking a reading the cell is on open circuit.

Mr. Blakesley asked if the authors had tried the method in which the resistances are adjusted till, when the battery circuit is broken, there is no immediate change in the galvanometer deflection. It was possible by this method to measure a resistance of between 6,000 and 10,000 ohms to within 0·1 per cent.

Prof. Ayrton said the method referred to by Mr. Blakesley was the ordinary "false zero" theory. In using this method it was a case of working to a continuously altering zero. In Prof. Stroud's method, however, the zero was constant.

Mr. Appleyard said he had found the "false zero" method troublesome to use.

Prof. Stroud, in reply, said they had not tested the proportionality between the resistance and length, and they had not tried the "false zero" method.

Mr. Appleyard then exhibited a number of different forms of electrical "Trevelyan Rockers." The most interesting one consisted of two rods of carbon fixed to a wooden sounding-board, with a third carbon rod lying across the other two so as to form a microphone. A fairly strong current is passed through this microphone and through two electromagnets, which act on the prongs of a tuning-fork fixed to the sounding-board. The tuning-fork acts on the microphone, which by making and breaking the current keeps the fork in vibration. The cylinder of carbon forming the "knife-edge" of a small pendulum, supported on two horizontal carbon rods, kept the pendulum in violent oscillation as long as a current passed from one of the horizontal rods, through the movable cylinder, and out through the other horizontal rod.

The society then adjourned till November 13.

LEGAL INTELLIGENCE.

CLAIM FOR ELECTRIC LIGHTING.

In the Lambeth County Court on November 3 his Honour Judge Emden had before him the case of Froggatt's Electric Lighting Company *v.* Arden. The plaintiffs are electrical engineers, having a registered office at Lorrimore-street, Walworth, and they sued the defendant, Mr. W. H. Arden, of Draper-street, Newington-butts, to recover the sum of 18s. in respect of rent of electric lamps.

His **Honour** said the probabilities of the case were against the defendant, and he would have to pay for the lamps. The verdict would be for the plaintiffs for the amount of the claim, with costs.

THE ELECTRICAL FITTINGS CASE.

Mr. Justice Collins resumed on November 2 the hearing of the case of Andrews and Co. *v.* Ullathorne. In this case the plaintiffs sued the defendants, electrical engineers, of Bradford, to recover £483, the price of goods sold and delivered for use at the mill of Messrs Marshall, Kaye, and Marshall at Dewsbury. The defendants objected to the prices charged as being beyond those usually in force in the trade, and they counterclaimed for delay in sending the goods. They paid into court £173.

The learned **Judge** gave judgment for defendants, with costs of the claim and counterclaim.

WIGSTON ELECTRICAL AND ENGINEERING COMPANY, LIMITED.

In the Chancery Division, on October 28, before Mr. Justice Vaughan Williams, sitting as an additional judge in Chancery, under the Companies Winding-up Act, 1890, the petition of Messrs. Taylor and Hubbard for the compulsory winding-up of the Wigston Electrical and Engineering Company, Limited, Leicestershire, came on for hearing. It was a creditor's petition for £85. 14s. 1d.

Counsel stated that the Company had passed a resolution to wind up, and his **Lordship** made an order continuing the voluntary liquidation under supervision.

THE HOLOPHANE CASE.

In the Court of Appeal last week before the Master of the Rolls, Lord Justice Lopes, and Lord Justice Rigby, the case of Holophane, Limited, *v.* Hesseltine came up on an application by the defendant for a new trial of the action tried before Mr. Justice Lawrance and a jury in July last, or in the alternative for judgment to be entered for him.

Mr. Witt, Q.C., and Mr. Ernest de Witt appeared for the defendant; Mr. McCall, Q.C., Mr. Foa, and Mr. Cleave for the plaintiffs.

After hearing the arguments, the Court (Lord Justice Lopes dissenting) allowed the application, and directed judgment to be entered for the defendant, the **Master of the Rolls** saying that the question was whether the defendant had authorised Mr. Mygatt to apply for shares in his name, and whether Mr. Mygatt had acted on that authority. The authority, if any, was to make an application for 500 shares. It was not a proper exercise of that authority to apply for 320 shares. In his opinion the defendant was entitled to judgment.

THE HERMITE CASE.

The action, Hermite and Others *v.* the British Electrozone Corporation, Limited, has been dismissed on plaintiffs' own initiative.

COMPANIES' MEETINGS AND REPORTS.

BRUSH ELECTRICAL ENGINEERING COMPANY, LIMITED.

An extraordinary general meeting of this Company was held on Monday at the Cannon-street Hotel, E.C., Mr. J. B. Braithwaite presiding.

The meeting was to confirm the following resolution, which had been passed at a previous meeting: "That the capital of the Company be reduced from £750,000 divided into 150,000 preference shares of £2 each (of which 90,000 have been issued) and 150,000 ordinary shares of £3 each (of which 90,000 have been issued), to £660,000 divided into 150,000 preference shares of £2 each and 180,000 ordinary shares of £2 each, and that such reduction and alteration be effected by cancelling paid-up capital to the extent of £1 per share on each of the 90,000 ordinary shares which have been issued, and by reducing the nominal amount of the said 90 000 ordinary shares from £3 to £2 each, and by subdividing the 60,000 ordinary shares of £3 each now remaining unissued into 90,000 ordinary shares of £2 each."

The **Chairman**, in moving the resolution, said that it had been carried by a large majority three or four weeks ago, and he had practically nothing to add to what he said on that occasion.

Mr. B. H. Van Tromp seconded the motion, which was unanimously confirmed.

The **Chairman** said that the solicitors to the Company had advised that a formal poll would be necessary, in order to produce

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as evidence to the court. They had already received proxies in favour of the resolution representing 30,000 preference and 26,000 ordinary shareholders. On the other hand, they had received proxies representing 10 preference and 50 ordinary shares against the resolution, which, of course, he would use as directed.

As a result of the poll the resolution was confirmed almost unanimously.

BRITISH ELECTRIC TRACTION (PIONEER) COMPANY, LIMITED.

A meeting of this Company was held yesterday (Thursday) at Winchester House, Sir Charles Rivers-Wilson in the chair.

The **Chairman** said that the success of the Company had been sufficient to warrant the formation of a new company. That company would be called the British Electric Traction Company, Limited, dropping the word pioneer. The company would be formed with £600,000 capital, divided into 30,000 6 per cent. cumulative preference shares and 30,000 ordinary shares of £10 each. The new company had paid the Pioneer Company £25,000, which allowed a bonus of £1 per £4 share. The Chairman mentioned several provisional orders that will be carried over as an asset to the new company. He also stated that the company had secured the rights of the Esmond system by surface contact, to be used where it was found impossible to use the overhead trolley system.

SUBMARINE CABLES TRUST.

An extraordinary general meeting of the certificate-holders of this trust was held at the offices, Winchester House, the Marquis of Tweeddale presiding.

The **Chairman** stated that the object of the meeting was simply to fill the vacancy among the trustees. This had been caused by Sir John Pender's death, which they all deeply regretted. The gentleman who was proposed to fill the vacancy was well known to them all—Sir Albert J. Leppoc Cappel.

Mr. J. Denison Pender seconded the resolution, which was unanimously agreed to.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Munich.—Tenders will be received by the Postal Authorities on November 14 for 43,260 wooden telegraph posts.

Karlsruhe.—The Grand Ducal Railway authorities will receive tenders on November 9 for the supply of a quantity of telegraph posts.

Bressoux-lez-Liege (Belgium).—The Municipal Authorities are prepared to receive propositions for public lighting by (coal) gas, electricity, or acetylene.

Londonderry.—The Corporation invite tenders for the supply of carbons for one year from January 1 next. Full particulars can be seen in our advertisement columns.

Bucharest.—Tenders will be received at the Mairie, Bucharest, on November 16 for two stand-by steam-engines for a water-power electric generating station at Grozavesti.

Paris.—Tenders will be received on November 19 at the Chemins de Fer de l'Etat, Paris, rue de Châteaudun 42, for, among other supplies, a quantity of telegraph poles.

Arlon (Belgium).—Tenders will shortly be wanted at the office of Les chefs de service, Arlon, rue de la Station 36, for a building for an electric generating station at the Marbehan Station.

Alcazur de San Juan.—The Municipality will receive offers up November 17 for the electric lighting of the town for a period of 30 years. Alcazur de San Juan is in the province of Ciudad Real, Spain.

Malines (Belgium).—Tenders will be wanted for the supply at Malines of about six tons of special lubricating oil for dynamos and gas-engines. Particulars at the Brussels Bourse, where tenders will have to be sent.

West Looe.—The Parish Council invite tenders for the lighting of the place with gas, oil, or electricity. Full particulars from Mr. Wm. Hicks, hon. clerk, West Looe Parish Council. Tenders to be in by November 28.

Paris.—Tenders will be received by the Post and Telegraph Authorities at Rue de Grenelle 103, on November 20, for the supply of various parts of telegraphic instruments for the next five years. Application must be made before November 10.

South Shields.—The Corporation require tenders for a steam alternator and a rectifier, and extension to switchboards. Tenders are to be delivered by November 23. Specifications, etc., can be obtained at the Borough Electrical Engineer's Office, West Holborn, South Shields, on and after November 9, on payment of £1. 1s. (returnable).

Shoreditch.—The Vestry invite tenders for the supply of insulated wires and mains, insulated iron pipes, junction boxes, main switches, tumbler switches, cut-outs, ceiling roses, etc., for the ensuing year. Tenders and samples to be sent in not later than November 17. Particulars from Mr. C. H. Doughty, lighting engineer, Town Hall, Old-street, E.C. See advertisement.

Dundee.—The Gas Commissioners invite tenders for supplies of cast-iron pipes for electrical purposes, indiarubber-covered cables, and electricity meters. Particulars as to quantities, etc., can be had from the City Electrical Engineer, Dudhope-crescent road, Dundee. Persons willing to undertake the supplies required to send in tenders to the Clerk of the Commissioners, City Chambers, Dundee, by November 10.

Hartlepool.—The British Electric Traction Company, Limited, of 1 and 2, Great Winchester-street, London, E.C., on behalf of the Hartlepool Electric Tramways Company, Limited, invite tenders for the construction of the permanent ways. Particulars, specifications, plans, and form of tender may be obtained from Mr. J. Vincent Kitchener, secretary, London, on deposit of £5, which will be returned on receipt of a bona fide tender.

Warrington.—The Cheshire Lines Committee are prepared to receive tenders for the supply during the year 1897 of telegraph materials, instruments, wire, etc. Patterns can be seen and specifications with forms of tender obtained upon application to Mr. S. Saxon Barton, storekeeper, Cheshire Lines, Warrington. Tenders, sealed and endorsed, to be sent to Mr. Glegge Thomas, secretary, addressed Cheshire Lines Stores Department, Warrington, not later than 10 a.m. on November 28 next.

Southampton.—The Corporation invite tenders from engineers resident within the county borough for supplying and fixing the electric wires and fittings at the municipal offices, Guildhall, and police offices, Southampton, according to specification, which, with form of tender, may be obtained of Mr. J. H. Lee, A.I.E.E., Electric Supply Station, Back-of-the-Walls, Southampton. Sealed tenders, on the printed form, to be left at the office of Mr. George B. Nalder, town clerk, Municipal Offices, Southampton, by 2 p.m. on 13th inst.

Glasgow.—The Police Department of the Corporation invite tenders for the construction and erection of fans and motors for the new sanitary chambers, Cochrane-street, Glasgow. Specifications and forms of tender may be had and drawings seen on application at the office of Mr. William Arnot, electrical engineer of the Corporation, 75, Waterloo-street, Glasgow, and tenders, properly sealed and marked outside "Tenders for Fans and Motors," must be lodged with Mr. J. Lang, clerk, City Chambers, Glasgow, by 10 a.m. on November 9.

Copenhagen.—Provided the City Council will vote for spending the necessary amount, an electric station is to be built in Vesterbro, Copenhagen, and tenders are invited for the delivery of (1) boilers, (2) mechanical and electrical plant, and (3) network, in accordance with the description. Conditions and plans to be had upon application to the Electrical Station, 30, Gothersgade, Copenhagen. For each specification a fee of 50 kroner is charged, which is returned on acceptance of the tender. Tenders will be received at the office of the fourth division of the Magistracy until December 4 at 12 noon.

Maryborough (Ireland).—Tenders are invited for the supply and erection of an electric light installation at Maryborough District Lunatic Asylum by the Commissioners for the Control of Lunatic Asylums. Tenders should be sent in a sealed envelope, endorsed outside "Tender for Electric Lighting, Maryborough Asylum," and addressed to the Secretary, Board of Control, Customs House, Dublin, and should be accompanied by a separate sealed envelope similarly addressed and endorsed, containing the detailed estimate, by 10 a.m. on 23rd inst. Forms of tenders and copies of specification will be issued on application to the Office of the Board of Control of Lunatic Asylums, Customs House, Dublin, on deposit of £3. 3s., which will be returned to all persons who have sent in bona fide tenders. Plans can be seen at the office of the electrical engineer, Mr. Walter Leake, 35, Dame-street, Dublin.

Torquay.—The Town Council require tenders for the supply and erection of the following plant: (Section A) boiler-house plant—boilers and fittings, forced-draught apparatus, feed storage, etc.; (B) engine-house plant—steam alternators, condensers, pumps, steam and exhaust pipes, etc.; (C) switch-board, etc.; (D) underground mains, lamp-posts, etc.; (E) transformers, etc.; (F) meters; (G) accumulators, etc.; (H) crane, etc.; (I) builder. Tenderers are at liberty to tender for any section or sections, but not for part of a section. Specification, with terms and condition of tender and contract, may be obtained of Mr. W. H. Trentham, consulting engineer to the Council, 39, Victoria-street, Westminster, S.W., or of Mr. Fredk. S. Hex, town clerk, Town Hall, Torquay, on payment of £3. 3s., which sum will be returned on receipt of a bona fide tender. Tenders must be addressed to the Town Clerk, sealed and marked "Tender for Electricity Works," and delivered by 3 p.m. on November 13, the time having been extended.

Ayr.—The Electric Lighting Committee require tenders for the supply and erection of the following plant (the whole bound up in one specification, price £2. 2s., returnable on receipt of a bona fide tender): (Section A) boiler-house plant—two Lancashire boilers and fittings, mechanical stokers, extensions to economiser, feed-pump, steam and exhaust pipes, valves, etc.; (B) engine-house plant—two 200-kilowatt steam alternators and condenser; (C) underground work—cables and culverts. Tenderers are at liberty to tender for either section, but not for part of a section. The ground plans of plant and specification, with terms and conditions of tenders and contract, may be obtained at the offices of Mr. Robert Hammond, the consulting engineer to the Corporation, Ormond House, Great Trinity-lane, London, E.C., on and after November 10 on payment of £2. 2s. for each copy, which sum will be refunded on the return of the specification filled up with a bona fide tender. Tenders, sealed and marked "Tender for Electric Lighting," must be addressed to Mr. A. G. Young, town clerk, Council-chambers, Ayr, N.B., and be delivered by November 25.

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West Ham.—The Town Council require tenders for the supply of the following: four steam alternators and exciters; surface condenser and pumps; station switchboard, etc.; high and low tension mains, etc.; transformers, sub-stations, etc.; instruments; arc lamps, posts, etc.; crane. Plans of the suggested arrangements, specification, form of tender, and further particulars may be obtained at the office of Mr. John J. Steinitz, borough electrical engineer, Town Hall, Stratford, E., on the deposit of a £5 Bank of England note, which will be returned on receipt of a bona fide tender. Tenders, endorsed "Tender for Machinery, etc.," to be sent to Mr. Fred. E. Hilleary, town clerk, Town Hall, West Ham, by 4 p.m. on November 24. The contractor will be required to enter into a bond, with two sureties, for the performance of contract, and no work will be ordered under the contract until such bond has been duly executed. The contractor whose tender is accepted, and with whom a contract is entered into, will be required to pay the whole of his workmen such rate of wages and observe such hours of labour as are recognised by the workmen's trades unions and in force at the time of signing the contract. In the event of any breach of such agreement the Council will enforce the penalty clause in its entirety.

RESULTS OF TENDERS.

Whitechapel.—The Board of Works have accepted the estimate of Mr. Badger, at £110, for the supply of hydraulic motor pump.

Windermere.—The Council have adopted an agreement with the Electricity Supply Company, which includes the cost of lamp heads at 38s. each.

Bedford.—The Standing Joint Committee have accepted the tender of Messrs. Kilpin and Billson, of Bedford, for installing the electric light in the offices, corridor, etc., at the Shire Hall for £29. 10s.

Spandau.—The first tender on the published list for the supply of lightning conductors to the Friedrich-Wilhem-Bürger Hospital is from F. Crohn, Spandau, at 235 marks. The lowest is A. Ludewig, 184 marks.

La Rochelle.—From the consular report it appears that Mr. Caudrey, director of the Compagnie Générale de Traction et de l'Eléctricité, 24, Boulevard des Capucines, Paris, has obtained the contract for seven miles of tramway on the electric trolley system.

Clerkenwell.—The following tenders have been received by the London School Board for the electric light wiring and fitting work of the Board's store:—

J. O. Grant and Cocks	£870	0	0
Electrical and General Engineering Company	789	10	0
H. F. Joel and Co	748	0	0
Wenham and Waters, Limited	699	0	0
Strode and Co.	687	0	0
Edmundsons, Limited	649	0	0
C. A. Hemingway	628	0	0
Brush Electrical Engineering Company, Limited	598	0	0
C. E. Spagnoletti and Crookes (accepted)	550	0	0

BUSINESS NOTES.

Direct Spanish Telegraph Company, Limited.—For the month of October the receipts were £2,720.

Bristol.—The Electric Swimming and United Service Cricket Clubs had a very successful dinner last week.

Dewsbury.—During the three weeks ended October 18 6,221 units of electricity were generated, as against 3,391 last year.

Ealing.—It was stated at the District Council meeting that the number of 8-c.p. lamps now applied for was 9,160.

Train-Lighting.—The L. C. and D. R. Company are having 30 corridor carriages constructed which will be lighted by electricity.

Earl's Court.—The London Exhibitions, Limited, announces that its next exhibition at Earl's Court will be the Victorian Era Exhibition.

Aston.—The Local Government Board have sanctioned the Urban District Council's application for a loan of £350 for electric lighting at the offices.

The Public View.—The *Daily Mail* has published an interview with Mr. F. Hastings Medhurst, to show that electric lighting is not experimental now.

Bangor.—The question of electric lighting is the one topic in the town just now. A lecture on the same subject was delivered last week by Mr. W. H. Preece.

Gorton.—The District Council have resolved to apply to the Local Government Board for power to supply electricity in the district for lighting and other purposes.

West India and Panama Telegraph Company.—For the half-month ended October 31 the receipts were £2,407, as against £2,178 for the corresponding period of 1895.

West Ham.—Mr. G. W. Willcocks has held a Local Government Board enquiry into the application of the Council for sanction to borrow £50,000 for the electric lighting scheme.

Roumania.—The Municipality of Braila have determined on the construction of an electric tramway to Lacul Sarat. Negotiations have been started with the Helios Company, of Cologne.

Electricity in Mines.—The electrical transmission plant in Pigg's Peak Mine (South Africa) is working most satisfactorily, and is the only three-phase system at present in use in that country.

Waterloo.—The District Council have approved a plan for an electricity generating station on the west side of Brighton-road for the Liverpool and District Lighting Company, Limited.

South Kensington.—During the harvest festival service at St. Peter's, Cranley-gardens, last Sunday evening, the electric light, which has been installed about three weeks, suddenly went out.

Hampstead.—The Lighting Committee have decided to recommend the Vestry to pass a resolution in favour of lighting High-street and Haverstock-hill, to the boundary of St. Pancras parish, with arc lamps.

Reading.—The Town Council in committee have decided not to accept the invitation of the Reading Tramway Company to visit Bristol, as a body, to inspect an installation there of electric tramway traction.

Torquay.—The time for sending in tenders for electrical plant has been extended to Friday, November 13. We publish full particulars under the heading of "Contracts Open" in our advertisement columns.

Yarmouth.—Mr. G W. Willcocks has held a Local Government Board enquiry into the application of the Corporation for power to borrow £135 for lighting the Beach Gardens with five arc lamps of 1,200 c.p. each.

Newington.—The Vestry have decided to give notice in writing to the London Electric Supply Corporation, Limited, of the intention of the Vestry to apply for a provisional order to supply electricity within the parish.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ending November 1 amounted to £1,112, as compared with £1,046 in the corresponding week of the previous year, being an increase of £66.

Stafford.—Alderman W. H. Peach stated at the Town Council meeting that the rental in the electric light department for the quarter ending September 3 was £211. 16s. 9d., which was 15 per cent. more than in the previous quarter.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ending October 30 were £1,883. 4s. 5d., compared with £1 841 15s. 11d. for the corresponding period of last year, being an increase of £41. 8s. 6d.

Midland Cycle and Motorcar Exhibition Company, Limited. This Company has been registered with a capital of £1,000 in £10 shares. The object of the Company is sufficiently indicated by the title. Registered office: 174, Corporation street, Birmingham.

Belfast.—The Corporation have adopted a site in the Lagan-bank-road for the new central station. The present station has a capacity of about 17,100 lamps, and there are applications now for 17,145. The amount of money required for the new station will be about £50,000.

Islington.—The London County Council have agreed to lend the Vestry £24 000 towards the cost of the electric lighting installation. The question of providing tools for the machine shop at the lighting station comes up at to day's meeting of the Vestry. The estimated cost is £250.

Lamp Improvements.—We have received particulars of improvements which Messrs. E. Gossens, Pope, and Co. have made in fixing the caps of incandescent lamps. Owing to extreme pressure on our space we are compelled to hold over further remarks on this subject till another issue.

Rouen Exhibition.—Among the recipients of diplomas of honour at the Rouen Exhibition are the Franco-Belgian Tudor Company, and the Compagnie des Compteurs Thomson, and the India Rubber, Gutta Percha, and Telegraph Works, Persan-Beaumont. Mr. G. R. Blot has a gold medal.

Dublin.—The usual misleading statements as to electric lighting losses have been freely circulating in the town, and Mr. Wm. Buckley, chairman of the Electric Lighting Committee, has issued a long statement to the Press which shows the true state of affairs, and is a complete answer to the malicious allegations.

Birkenhead.—Alderman Deakin, replying to Mr. Hughes at the Town Council meeting as to the insurance with the Fine-Art Insurance Company, Limited, of the central electrical generating station, and the electrical plant therein, for £10,000, said the insurance was about one half lower than other companies.

Larne.—At the meeting of the Town Commissioners a discussion ensued with regard to the erection of new lamps at Gardenmore-place, Rodden's-road, and Memorial-avenue, and owing to the expiry of the Board's contract with the electric light company in April next it was agreed to defer the erection of new lights.

New Companies.—Veritys, Limited, has been registered, with a capital of £140,000. The first directors are J. B. Verity, G. H. Verity, J. E. Coles, P. G. Ebbutt, and C. L. Harris.—Savage's Engineering Works, Limited, which has just been registered, and takes power to construct electric works among other things.

Newington.—The Electric Lighting Committee of the Vestry recommended at the last meeting of that body that notice should be given in writing to the London Electric Supply Corporation, Limited, of the intention of the Vestry to apply for a provisional order to supply electricity within the parish. After discussion the recommendation was agreed to.

Dover.—Councillor G. Mowll asked at the Town Council meeting if they were going to take any further steps towards charging the Telephone Company a fairer rental for their poles than a shilling a year. The Town Clerk said they would have to give the company first notice to terminate the present agreement. A motion to that effect was carried.

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Harrow.—At the Urban District Council meeting a notice was received from Mr. Hawtayne, consulting engineer to the Harrow Electric Light and Power Company, stating extensions of main would be made down the High-street to South-hill-avenue, Byron-hill to Middle-road, Peterborough-road to Station-road, to opposite the Victoria Hall, taking Lyon, St. John's, and Gayton roads.

Poole.—The Sunlight and Safety Lamp Company, Limited, have received the consent of the Poole Town Council to fix two or three of their lamps in the borough by way of experiment, and the Bournemouth and District Electric Supply Company, Limited, have had the consent of the Council to an application for a provisional order for supplying electricity within the borough.

Longton.—At the meeting of the Town Council the committee recommended that the agreement between the Corporation and the British Electric Traction (Pioneer) Company, Limited, for the construction and working of light railways in the borough, and from Longton to Trentham and Blyth Bridge be approved, and the common seal of the borough affixed thereto. The report was adopted.

Barking (Essex).—At a meeting of the Urban District Council it was suggested that it was time the old system of oil illumination should be done away with and electricity employed instead. Some of the councillors suggested gas, but eventually it was decided to obtain a report from Mr. Hawtayne, of 20, Bucklersbury, on the possibility of lighting by electricity, before anything further was done in the matter.

Aberdeen.—The Gas and Electric Lighting Committee of the Town Council have agreed to erect a new water superheater for the boilers at the electrical station, the estimated cost being £400. The Town Council have agreed to execute the works necessary for supplying electric light to the harbour quays. The cost of the works will be £9 336. The Commissioners agree to pay for an annual supply of not less than 80,000 units.

Barrow.—The Gas and Water Committee are considering the proposal from the British Thomson-Houston Company to work the trams by electricity. The committee have also under consideration the question of laying down an electric lighting installation. The Watch Committee want the National Telephone Company to supply metallic circuits in connection with the telephone system between the central police station and outlying districts.

Lambeth.—With reference to the proposed transfer of the electric lighting provisional order now held by the Lambeth Vestry to Mr. Julius Sax, the Board of Trade have written pointing out certain objections to the transfer of the order to an individual. The Vestry have sent a copy of this letter to Mr. Sax for his observations, and a small committee has been formed to consider the letter and Mr. Sax's reply, and to report thereon.

The Cyanide Case.—Judgment was given on Wednesday at Pretoria in the action brought by Mr. James Hay against the African Gold Recovery Company to decide whether the patent rights of the company in the McArthur-Forrest gold extraction process, generally known as the cyanide process, are valid in South Africa. The decision is in favour of the plaintiff, with costs. Patents 47 and 74 are set aside on the ground of want of novelty.

Hoylake and West Kirby.—The District Council have resolved to apply, on or before December 21, for a provisional order under the Electric Lighting Acts, 1882 to 1888, to authorise the supply of electricity by the District Council for public and private purposes within the Council's area. A sub-committee especially dealing with the parliamentary Bill—Messrs. Cook, Bird, Aldred, Wall, Ellison, and Dr. Wilkinson—was appointed to consider the question.

Salford.—The Town Council have resolved to apply for a provisional order to construct tramways by a connection with the existing lines in Broad-street, Pendleton, along Cross-lane and Trafford-road, and connecting with the tramways in Chester road, within the urban district of Stretford; also from the existing double line in Eccles New-road, and passing along that road to a point opposite the Manchester Carriage and Tramway Company's offices at Weaste.

West Hartlepool.—A resolution was passed at a meeting of telephone subscribers expressing indignation at the great inconvenience which has been experienced in the use of the telephone service since the trunk lines have been under the control of the Government, and demanding that immediate steps be taken to remedy the grievance, which consisted of great and unreasonable delays in communication, practically rendering the system useless for business purposes.

Wrexham.—The Town Council have decided that the compulsory area of supply of electric light be High-street, Hope-street, Regent-street, Queen-street, Henblas-street, Charles-street, Townhill, and Chester-street, up to the Guildhall, and that the area proposed to be included in the powers of the order beyond the municipal boundary shall comprise the portions of Stansty and Broughton lying within the parliamentary borough, and the townships of Bersham, Erddig, Abenbury, and Acton.

Phonographs.—The Edison-Bell Phonograph Corporation, Limited, have given notice that, in the action brought by them against Mr. J. E. Hough, Mr. Justice Romer, on October 28 last, granted a perpetual injunction restraining infringement of their patent No. 6,027* of 1886, and that they will commence actions for infringement of their patents against all persons in the United Kingdom found dealing in or using phonographs, graphophones, records, or cylinders not purchased or leased from them or their agents.

Archbishop Tenison's School, Leicester-square.—Important structural alterations have recently been effected at this school in order to bring it up to the required standard as an organised science school. A new floor has been inserted about halfway up the large hall, having an area of 60ft. by 25ft., which has been equally divided into chemical and physical laboratories, each of which has accommodation for 20 students. The total cost has been approximately £900. The schools were formally opened last week.

Telegraphic Rates to Japan.—The Liverpool Chamber of Commerce have received a further letter from the Postmaster-General on the subject of rates for telegrams to Japan, stating that as a result of the negotiations at Budapest the rate to Japan will be reduced from 8s. to 6s. 2d. per word by the route of the Great Northern Telegraph Company. The rate of 10s. 8d. per word by the route of the Eastern Extension Telegraph Company will also be reduced, but in the latter case the reduced rate is not yet definitely settled.

Norwich.—Speaking the other day at a meeting in support of a candidate in the recent municipal elections, Mr. George White stated that a very important scheme would shortly be before the city. This was a scheme for giving Norwich electric tramways. There was not a town in civilised Europe as important as Norwich which did not possess tramways. There would be many difficulties in the way, and rival systems would be placed before the citizens, but he hoped some system, before many months were over, would be adopted.

Birmingham.—The Public Works Committee and the directors of the City Tramways Company have had a meeting. The committee agreed to a scheme, which was to run a line along Navigation-street to the bottom of Lower Temple street. The other important new route agreed to was one to relieve the Perry Barr lines. The committee gave permission to lay down rails in Church-street, so as to bring the trams from Snow-hill by way of Lionel-street or Great Charles-street and Church street to Colmore-row. Other routes were also decided upon.

London Lighting Extensions.—The London County Council at their last meeting granted applications for extensions of mains, etc., from the London Electric Supply Corporation, the Metropolitan Electric Supply Company, the Westminster Electric Supply Corporation, the Vestry of St. Pancras, the Notting Hill Electric Lighting Company, the House-to-House Electric Lighting Supply Company, the Kensington and Knightsbridge Electric Lighting Company, the Charing Cross and Strand Electricity Supply Corporation, and the Vestry of Hampstead.

City of London Electric Lighting Company.—The gross revenue return for the quarter ended September 20 shows that the revenue from the sale of current for public lighting was £3,158, against £3,182 for the corresponding quarter last year; from private lighting, etc., £17,274, against £11,600; and from other sources (estimated) £750, against £400—the total being £21,182, against £15,182, an increase of £6,000. The equivalent of 8-c.p lamps connected on September 30, 1896, was 228,740, an increase during the quarter of 13 181; as compared with 170,827 last year.

New Deer.—The Village Lighting Committee are hard at work following up the proposal that the village should be lighted by electricity. They have interviewed several electrical firms in the south as to construction and probable cost. Last week a representative from one firm paid the village a visit, and reported very favourably in various ways about the matter. Motive power can be had from water quite close to the place. A local surveyor has been instructed to take levels in the village as soon as possible. It is proposed to raise funds by issuing shares and forming a company, which has every probability of paying well.

Hammersmith.—The Electric Lighting Committee reported at the Vestry meeting that the surveyor had been in communication with the Brentford Gas Company, who were willing that the gas lamps along the route to be lighted by electricity should remain for a time in their present positions, and if no gas was consumed no charge would be made except for maintenance. The committee recommended the Vestry to confirm the arrangement. Mr. Cubitt asked if the present lamp-posts would be used for the purposes of electric lighting, and Mr. Searle replied that they would not be so used. The recommendation was agreed to.

Lisburn.—At the Town Commissioners' meeting Mr. Harvey impressed upon the Streets Committee the importance of doing something to improve the lighting of the town. They had been making improvements in other departments, and he did not know how it was that they were content to allow the town to remain in comparative darkness. Mr. Boyd said it would take double the number of lamps to sufficiently light the thoroughfares. Mr. Diamond said the Streets Committee had been making enquiries on the subject of electric light. Mr. Wilkins said they had been investigating the matter, and he hoped before the end of the year they would be able to make a definite proposal.

Gloucester.—Mr. Karn called attention at the City Council meeting to the inadequate lighting of Eastgate-street, and suggested that the two lamps opposite the Guildhall should be lit. Mr. Woodward congratulated the committee on putting new lamps in the suburbs. Mr. C. H Clutterbuck said this matter had received the serious consideration of the Streets Committee, and they would have liked to provide the four principal streets with lamps suitable for present-day requirements, but they found that the cost would amount to £600 or £700—too large a sum to expend with the prospect of adopting the Electric Lighting Act. Anything, however, that they could do in the shape of a temporary improvement should be done.

Fenton.—The General Purposes Committee reported at the Urban District Council meeting that a communication had

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been received from Messrs. Milward and Co., Birmingham, giving notice that an application was about to be made to the Board of Trade for their approval of the transfer of the undertaking authorised by the Potteries Extension Tramways Order, 1896, from Messrs. Sellon, Fell, Ashby, and Garcke to the British Electric Traction (Pioneer) Company, Limited, and that any objections or representations with respect to such proposed transfer should be made on or before the 19th inst. The committee recommended that no objection be made to the proposed transfer. The recommendation was adopted.

Brighouse.—A special meeting of the Town Council has been called to take into consideration the expediency of applying to the Board of Trade for a provisional order under the Electric Lighting Acts, 1882 and 1888, to authorise the supply of electricity for public or private purposes within the borough. The Council agreed some time ago, subject to getting this sanction, to purchase from Mr. A. B. Brook, electrical engineer, his electric lighting plant, with which he has been supplying tradesmen and others in the borough with the electric light during the past three years. The Corporation also own the whole of the gas supply in the borough, having during the past 12 months obtained possession of the Rastrick gasworks at a cost of £50,000.

Luton.—A letter was read at the Rural District Council meeting from the National Telephone Company, asking permission to erect poles on the road from Dunstable to Totternhoe. The usual conditions would be entered into, and the company would pay 6d. per pole. The Clerk said his usual experience was that 2s. 6d. per pole should be charged. The representative of the company said they paid 2s. 6d. for the trunk lines, where the poles carried about 20 wires. In the present case the poles would only carry two wires. He was prepared to offer 1s. per pole. The company was endeavouring to open an exchange at Dunstable. It was decided to object to the poles being erected at a less charge than 2s. 6d. each. The representative said that being so, he was afraid the line would never be set up.

Telephone Employes' Wages.—A deputation from employés of the National Telephone Company throughout the country has waited upon the chief officials of the company in London. Lord Harris, vice-president of the company, presided over the proceedings, which were conducted in private. The chief point in dispute had reference to an increase in the number of hours to be worked in Yorkshire without a corresponding increase in wages, and in connection with this a strike was only averted a few weeks ago by the conciliatory attitude of the company. It was now intimated to the men that Lord Harris would visit the district affected and personally investigate the matter, the men in the meantime to work on the old basis. The questions of wages in London and the payment of overtime were also discussed, and attention was promised at an early date.

Bradford.—The Gas and Electricity Committee have issued notices to all their consumers that they will be entitled on and after January 1, 1897, to one 8-c.p. or 16-c.p. incandescent lamp, supplied free of charge by the Corporation, for every 60 units of electricity consumed since July 1, 1896, by the use of incandescent lamps only. If other and higher candle-power lamps are desired instead of 16 c.p., the number of lamps to which the consumer is entitled will be in the inverse ratio to such candle-power. Thus, 60 units entitles to one 8-c.p. or 16-c.p. lamp; 120 units entitles to two 8-c.p. or 16-c.p., or one 32-c.p.; 240 units entitles to four 8-c.p. or 16-c.p., or two 32-c.p.; 480 units entitles to eight 8-c.p. or 16-c.p., or four 32-c.p., or two 50-c.p. (The balance of units consumed in excess—viz., 105—in this last instance being held over until the following six months' supply, or made up by lamps of a lesser candle-power as may be desired by the consumer.)

Bromley.—A letter was read at the Urban District Council meeting from Messrs. Waterer and Dickins, Market-square, thanking the Council for the statement of the expenditure by the late Local Board in connection with the electric lighting provisional order—viz.: Board of Trade fees and deposit, £50; engineer's fees, £105; printing order, etc., £117. 18s.; advertising, £73. 6s. 6d.; miscellaneous, £14. 18s. 9d.—total, £361. 2s. 3d.—upon payment of which the Council was prepared to transfer their interest in the said order to a small company. The proposed company was prepared to pay the amount subject to approval of such a condition as would be imposed by the Board of Trade retaining the right of purchasing the undertaking by the Council at the expiration of, say, 21 years, or at any subsequent period. They would be glad if the Council would submit the transfer form, to take effect within, say, six months, and in the meantime their clients would set about the formation of a company and the acquisition of a central site and other preliminaries. The matter was referred to committee.

The London Tramways Scheme.—The Finance Committee reported at the last meeting of the London County Council upon the financial bearings of the estimate of £675,000 for the purchase price. They submitted the estimate as chargeable to capital (original outlay) account. The Finance Committee had very carefully considered the subject in the light of the fuller information now placed before the Council, and had also had before them the published accounts of the companies for the year to June 30 last, which showed a considerable increase both in gross receipts and net profits. With this fuller information the committee had come to the conclusion that the offer of the North Metropolitan Tramways Company was not sufficiently advantageous financially to the Council to justify them in endorsing it as it stood, but they thought it expedient to set out their reasons in view of the possibility of further negotiations between the Council and the company. The report was referred back to enable the Finance Committee and the Highways Committee to confer as to the points which were not considered sufficiently advantageous to the Council.

Berlin.—The Upper Silesian steam railway company, which passes through the whole industrial district of Upper Silesia, has determined to use electric traction instead of steam locomotives. The electric traction will be introduced at first both for passengers and freight traffic on the lines—(1) Gleiwitz, Zabrze, Koenigshuette, Beuthen, Deutsch Piekar, and (2) Koenigshuette, Cattowitz, Laurahuette, Koenigshuette, for which 30 motorcars and a corresponding number of trailers are provided. The cars are mounted on two swivel trucks of 785mm gauge. Each of the four axles will be driven by a street railway motor of 18 h.p. to 20 h.p. The Elektricitäts Gesellschaft (Felix Singer and Co.) inform us that they have got the order of the electric installation of these cars, consisting of 120 motors and the whole electrical outfit. Their firm, assisted by the Walker Company, whose representatives they are, have devised a new special motor type for the small gauge. The whole length of both lines is about 20½ miles.

Brewers' Exhibition. — The Brewers' Exhibition has been running during the present week at the Agricultural Hall, Islington. The Improved Electric Glow Lamp Company, Limited, of Queen Victoria-street, E.C., have a stall there, and show their new designs of lamps. There are ammeters and voltmeters, so that it can be seen what the lamps take in the way of current and the light you get for it. Messrs. Glover and Co., of 97, Queen Victoria-street, show lamps, fittings, and a quantity of electrical cooking and heating apparatus Messrs. Charles Johnson and Sons, of Worcester, show forms of telephone suitable for warehouses, hotels, and private houses, or, in fact, any distance short of a mile. The India Rubber, Gutta Percha and Telegraph Works Company, Limited, have a stall, but naturally the telegraphic part of their work is not represented at a brewers' exhibition. There may have been more, but we did not notice them in the course of a cursory visit. What we did notice, however, was the impudent way in which in some instances the title "electric" or "electrical" is attached to goods with which electricity has nothing whatever to do.

Leeds.—A special meeting of the Tramways Committee has been held for the purpose of receiving a report respecting a site on which to erect a depôt for the new electric motorcars. The sub-committee recommended that a site of land comprising 16,825 square yards, in Kirkstall-road, known by the name of "Piggeries," should be acquired by the Corporation for the proposed new building. Originally the owners asked 14s. a yard for the site, but they were now willing to dispose of it at 13s. 3d. a yard, or for about £11,146 for the whole area. The Chairman stated that it was absolutely necessary that something should be done, as Messrs. Greenwood and Batley, the contractors for the supply of the electric motorcars, reported that they had now several cars ready for delivery, and the Corporation had at present nowhere to put them. The committee resolved to purchase the site recommended by the sub committee, and this decision was afterwards confirmed by a meeting of the full Highways Committee which was held afterwards. Mr. Connellan, during the course of the meeting, elicited the information that the extension of the Roundhay tramlines to the Canal Gardens would be completed in three weeks or a month. Until the electric cars are ready, steam cars will be run on these lines.

Western and Brazilian Teleg'aph Company, Limited.—The report of the directors for the half-year ended June 30 last, to be presented at the general meeting to be held in London on Thursday next, states that the total earnings amounts to £71,082, as against £84,937, a decrease of £13,855 compared with the half-year to June 30, 1895. The loss of revenue for the half-year, as compared with the corresponding period, is owing to the diminution of the internal traffic of Brazil, probably occasioned by the disturbed state of commercial affairs. The working expenses amounted to £37,428, as against £37,891, a decrease of £463 Including the amount brought forward from 1895 (£4,953), the balance to the credit of the revenue account is £38,606, from which has to be deducted £10,750 for debenture interest, £5,000 for the debenture redemption fund, £1,719 for income tax, and £3,000 placed to reserve fund. The directors now recommend the payment of a dividend, free of income tax, for the half-year at the rate of £2 per cent. per annum, as against £2. 10s. per cent. per annum for the corresponding period, carrying forward £3,530. The conversion of ordinary shares into preferred ordinary and deferred ordinary is suspended until further notice. The traffic receipts for the past week were £2,988.

Wallasey.—Mr. Rienzi Walton, M.I.C.E., has held a Local Government Board enquiry into an application by the Urban District Council for powers to borrow £17,500 in respect of a scheme for electric lighting. Mr. W. Danger, clerk to the District Council, stated that an application was made to the Board of Trade 12 months ago for a license. This was granted for two years, and a large proportion of the work under the original scheme had been carried out. It was felt, however, that the time was rather limited, and the Local Government Board practically promised, if a provisional order were applied for, to extend the time to 25 years. The application for a provisional order was in hand now. The electric lighting movement was popular in the district, and there appeared to be a consensus of opinion that the improvement was necessary, and that the District Council were justified in going to the expense. The work under the existing license would absorb £12,500, and it was felt that the balance of £5,000 would be sufficient to meet the demands of the next two years or more. Mr. R. M'Geoch said the applications already received for the electric light would nearly pay the interest on the

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capital and the expense of working. It was considered likely that the consumption of electric light would be trebled before two years had expired. There was no opposition.

Grantown.—For some time a proposal has been before the town with the view of having it lighted by electricity. The River Spey would be utilised to provide the necessary power. The scheme reported on by Messrs. Stewart and Co., Limited, of Glasgow, for the purpose of introducing the electric light shows some interesting features. It rejects the idea of using a water-wheel in favour of the turbine. It was after inspection decided to take advantage of the more rapid part of the fall by building the power-house at a point about 20 yards up from the bridge, and to excavate a lade to carry a body of water 20ft. broad and 6ft. deep at a speed of about 2ft. a second. The lade would tap the river at a point 600 yards above the power-house, from which point to the bridge there is a fall of 8ft. 6in., which would allow an effective fall at the turbine of at least 7ft. One turbine of 70 h.p. is considered enough for present needs. The motor is known as the Achilles reaction turbine, horizontal type. The wheel is 48in. in diameter, and the guaranteed horse-power under a 7ft. head is 72, while the water used is 6,800 cubic feet per minute. The plant would be sufficient to maintain 1,000 lamps of 16 c.p., or 2,000 lamps of 8 c p. The report claims that electricity can be provided at a cheaper rate than either oil or gas lighting, and points out that the scheme admits of supplying Castle Grant, a distance of two miles; Inverallan House, a distance of one mile; and Balmenach Distillery, which is about three miles from the proposed power-house.

Appointments Vacant.—The professorship of natural philosophy in the Queen's College, Belfast, being about to become vacant, candidates for that office are requested to forward their testimonials to the Under Secretary, Dublin Castle, on or before 21st inst., in order that the same may be submitted to his Excellency the Lord-Lieutenant.—The Public Works Committee of Birmingham invite applications for the following appointments in the city surveyor's department—namely, electric inspector and assistant electric inspector. Candidates for the post of electric inspector must be thoroughly qualified electrical engineers capable of undertaking efficiently the duties of electric inspector under the Birmingham Electric Lighting Order, 1894, and of advising upon, preparing specifications for, and carrying out all electrical matters devolving upon the city surveyor's department Salary £200 per annum, rising by annual increments of £10 per annum to £230 per annum. Candidates for the post of assistant electric inspector must be competent electricians. Commencing salary £78 per annum. Candidates for both appointments must not exceed 35 years in age. Applications, in candidates' own handwriting, stating age, experience, past and present employment, accompanied by copies of not more than three recent testimonials, to be sent to Mr. John Price, city surveyor, The Council House, Birmingham, by 20th inst. Canvassing will be a disqualification. The following external examinerships in the Victoria University will fall vacant in December, 1896. Each is tenable for three years, at the expiration of which the examiner is not eligible for re-election: chemistry, mathematics, physics, etc. Further particulars may be obtained from Mr. Alfred Hughes, registrar, The Victoria University, Manchester.

Brighton.—The *Sussex Daily News* says: "Few people in Brighton can have any idea of the magnitude of the business carried on by the Lighting Committee as purveyors of electricity. Already Brighton consumes twice as much electric current per head of population as any other town in Europe, and the demand increases so rapidly that the supply, with all the recent developments at the generating station in North-road, can hardly keep up with it. An important addition to the machinery is due in December, but Mr. Wright, the Corporation electrical engineer, has had to anticipate its arrival by borrowing, and if new applications for current come in at the present rate, it will not be long before the extended engine-room at the works is filled with whirling dynamos. Up to 1895 the highest increase in private consumers in any one year was 197, but up to October 1 the present year had yielded 293 new applications, making a total of 1,322 private consumers connected with the mains. The private lamps number 60,000—a surprising total, all things considered—while there are at present 480 incandescent lights in street lamps, and 170 arc lamps. It should also be mentioned that 100 more arc lamps are in preparation for street-lighting, and that the committee, wherever they run new mains, are fitting the existing street lamps with incandescent lights The great success of the undertaking Mr. Wright ascribes to the forward policy of the committee in pushing mains, even into back street, wherever it has seemed possible for business to be done. Experience at Brighton has shown that wealthy districts and streets of large shops do not necessarily furnish the most profitable consumers of electricity. The few lamps burnt in side streets for a longer period every evening pay better, and the sliding scale adopted by the committee—known generally as the 'Brighton' scale—makes the price to such consumers, it is claimed, considerably lower than that of gas Hitherto the light has been considered a luxury; now it seems it is going to prove an economy, especially as it is quite possible that further reductions in price may be made. The committee in 1894, having a large surplus, immediately reduced the rate, thinking it only fair that those who made the profits should benefit by it. If this principle should again be supplied, Mr. Wright thinks more people will find it profitable to make use of the current for motive power. Some 60 motors are now used for various purposes in the town, and a small reduction of price would make electricity a dangerous competitor with steam and gas, even in large works." Owing to an intimation received by the Town Council that the insurance companies have decided on a considerable advance in the fire insurance premium on the electricity works, the Council have decided to renew the insurance only until Christmas next, and to become their own insurers by creating a reserve fund.

Darwen.—At the Town Council meeting the Mayor moved that the Council apply to the Local Government Board for a provisional order conferring the right to produce, store, and supply electricity for public and private purposes within the area of the borough. Mr. Wardley seconded. Alderman Davies moved that action in regard to obtaining powers to supply electricity should be postponed for further enquiries. He said there had not been shown any very great demand for the electric light in the town, and it was absurd to speak of applying for powers to supply the technical school, upon which they had already spent a considerable sum of money in putting down a dynamo already. As to electric traction for tramways—well, he had heard of castles in the air, but he thought the castle of electric traction for the tramways was likely to remain there for a long time. He analysed the report submitted by Mr. Lacey, the expert, and he said that if the ratepayers went in for the light they would find their rates increasing in another direction. The cost would not be less than £20,000 for the electricity works they would be compelled to put down, and they could not expect to obtain a longer period for borrowing powers than 25 years. He estimated that they would have an adverse balance of £2,000 at the end of the two years, although the expert said they would have a profit on their second year's working, and that had been the experience elsewhere. There had been no expression of opinion that the people wanted the electric light. That thing was being rushed through, irregularity and inaccuracy being apparent wherever they looked, and he asked what could be the result of a movement begun in such a manner. Alderman Duxbury seconded. The Town Clerk explained the effect of the order. They would be able to limit their compulsory area to two or three streets. Mr. Forest said it had been stated that there was no demand for the electric light, but anyone who had his eyes open in the town would not say that. He pointed out that some of the opponents to the scheme were inconsistent, having put down electric lighting plants at their homes and mills, and he asked them to be consistent. The idea of electric traction for the tramways had been scoffed, but he ventured to say that in completing an agreement with the Blackburn Corporation the tramway company had handed themselves over to the Darwen Corporation, who could compel them to take electric traction when it was ready in 1897, or hand over the tramways to the Corporation. The Town Clerk suggested that they should instruct him to prepare and advertise the necessary notices and convene the necessary meeting, to enable the Council to apply in the next session of Parliament for power to supply electric light for public and private purposes. This was decided upon. The surveyor reported that Messrs. R. and T. Tootall, of Crown-street, were laying overhead electric wires from their foundry in Crown-street to premises in Bridge-street, owned by the Co-operative Society, with a view to supplying electricity. The town clerk was instructed to deal with the matter.

The Improved Electric Incandescent Lamp.—The improvement in Mr. Fanta's lamp, which is being brought out by the Improved Electric Glow Lamp Company, consists essentially in depositing a mirror on the stem half of the globe. This seems a simple thing to do, but in practice it has not proved so—that is to say, to do it in such a manner as will stand in ordinary use without deterioration. At any rate, no such lamp is in common use. It is clear that by a metallic mirror surface in optical contact with the glass of the lamp bulb the condition for securing the maximum amount of reflected light is obtained, and the difficulty that besets all metallic mirrors exposed to the air—namely, their rapid tarnish—is avoided. If, however, silver is deposited on the glass by any of the ordinary processes, and then simply painted or varnished over for protection, it is found that the expansion and contraction which follow the heating and cooling of the lamp cause either a cracking or a separation of the film and covering. A film of some tenacity is required, and probably one which being a good conductor of heat may be trusted to keep at a lower temperature than that of the glass. Mr. Fanta meets these requirements by electrolytically depositing on the thin silver film a coating of copper, which, of course, can be carried to the thickness which is judged necessary. As a matter of fact, the metal when peeled off the glass—an operation not to be performed without breaking the lamp—is seen to be a very thin foil indeed. At the outset difficulties were encountered, owing to the fact that the thin silver film which was chemically deposited could not be in any way cleaned to receive the copper. This caused spotting from occasional failure to secure metallic contact due to residues left by the depositing solution. The way out of the difficulty proved simple. It was to "inoculate" the copper-depositing bath with some of the silver deposit instead of attempting to work with as pure a bath as possible. In addition to the mirror deposited on it the shape of the lamp is changed. The ordinary pear-shaped bulb does not give the proper shape for a reflector. Of the two shapes adopted in the "improved" incandescent lamp for ordinary lighting, one is that of a simple sphere, and the other is an oblate affair, like an ordinary round door-handle, or, if the open top were domed over, like the bowl of a champagne glass. For some reason inscrutable to any but themselves, the company are pleased to call this shape a "conical" lamp—a greater outrage on geometry than even the conical shot of the gunnery people. The result of the shallowing of the bulb appears to be to

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cause an extra turn to be put in the filament. Beyond this there is stated to be nothing special in the construction of the lamp, and, as a matter of fact, they are being made for the company in England by the Ediswan Company. The lamps we have seen are 100-volt ones, but with a very slight modification bulbs of the new shape are made to take the longer filament required for 200 or 220 volts. Of course photometric measurements are beside the mark, as the amount of light to be used is the same whether a lamp has a reflector or not. The question is, how much of this light is to be utilised and how much wasted? It can, however, be said that if "Improved" lamps are substituted in an electrolier for ordinary lamps of the same nominal candle-power, the effect is most marked. The only question appears to the writer to be whether the mirror will stand in use, and Mr. Fanta assured him that there was no trouble in this respect, and that the mirror always outlasted the filament. The lamps as sent out are stated to be rather above their nominal voltage, so as to secure a long life. A prosaic detail remains—namely, price; and the cost of the "Improved" lamp is about 6d. more than an ordinary incandescent lamp without a mirror. The new lamps have already come into use in several places, and, among others, at the "Empire" in Leicester-square. The Improved Glow Lamp Company are also responsible for the electric lights carried by the dancers in the "Monte Cristo" ballet there, and the arrangements possess some interest because the use of primary or secondary batteries is abandoned, and the alternating current from the mains of the Metropolitan Electric Supply Company transformed down to about 25 volts is used. But that is another story, and one to which we hope to recur.

Another Electric Railway.—According to the *Times*, there is a plan on foot, of which the details have been most carefully considered, for making an underground electric railway from Hammersmith-broadway to Cannon-street. For the capital of this undertaking no appeal to the public is needed. It is believed that, should the sanction of Parliament be accorded next session, the Hammersmith and City electric railway will be open for traffic in well under four years from the present time. The route to be traversed is as follows: From "Cannon-street station," which will be at the south corner of Bread-street, where St. Mildred's Church now stands, under Carter-lane and by a double curve to Ludgate-hill, with "Ludgate-circus station" a little way along on the north side of Fleet-street. The "Law Courts station" will be on the south side of the Strand on the site of Thanet-place, with a subway, probably, leading from the Temple to the courts, under the road. The next stopping place will be "Wellington-street," the station being put at the south-west corner, almost exactly opposite the Lyceum Theatre. Leaving the Strand to pass under King William-street the line will reach "Trafalgar-square" station at the end of St. Martin's-lane, close to the National Gallery, and will then pass by way of Leicester-square and Coventry-street to Piccadilly-circus, where the station will be found at the corner of the Haymarket adjoining the Criterion Theatre and Restaurant. From this point to Hammersmith the tunnels will follow the line of the high road, the stations being "St. James's" at the corner of Arlington-street, "Hyde Park-corner" on the west side of St. George's Hospital, "Knightsbridge" at the beginning of the Brompton-road, "Albert Hall" on the west side of the building, "Kensington Church" at the corner of Church-street, "Earl's Court-road," "Addison-road," backing on to Olympia, and "Hammersmith," the terminus, a little to the east of the District station and almost opposite the West London Hospital. The works and depôt will occupy some acres of land lying between the Hammersmith-road and Brook-green. The total length of the proposed line is just under six miles, and it will be contained in double tunnels, having an internal diameter of 11ft. 6in. These, together with the lift, shafts, and the station tunnels, of which the internal diameter will measure 21ft., will be made in iron segments, no brickwork entering into their construction at all. The depth of the line is to be at least 60ft. below the street level, and the whole of it, with the exception of a small part in the City, will pass beneath the roadway. The soil through which the tunnels will be driven is London clay throughout. This has been ascertained by careful borings, and no engineering difficulties are feared. It may be mentioned here that the projectors are in active consultation with Sir Benjamin Baker as to the construction of the new line. The trains are to be made up of corridor carriages built on the tramcar principle with platforms at each end. These carriages will be 45ft. in length, containing seats for 48 passengers. Seven of them will make up a train, which will thus accommodate 336 persons. There will be either a 2 or a 2½-minute service all through the day, since the promoters count upon a very large intermediate traffic They do not, they say, expect to compete so much with the underground railway as with the omnibuses, which they rely upon excelling, as regards both speed and comfort. Especially do they look for a very considerable evening traffic from the patrons of evening entertainments of all kinds. The journey from one terminus to the other will take not much more than half an hour, including the stoppages at each of the 12 intermediate stations. With regard to the cost of the undertaking, which, as was stated at the outset, will be subscribed by a small syndicate without any capital being publicly issued, it is calculated that the expense of construction, including the stations and the general equipment of the line, will come to about £500,000 per mile. The system of electric traction to be adopted will be decided upon later, and any new development that may take place in this direction will be taken advantage of when the date for the final choice arrives. Steps are now being taken by Messrs. Ashurst, Morris, Crisp, and Co. for the presentation to Parliament in the ensuing session of a Bill embodying the scheme that has been thus roughly sketched out, and, though the promoters are quite prepared to see determined opposition offered to their proposal, they are resolved to press it forward as energetically as possible, and, even if beaten once, to persevere until they succeed. They expect, no doubt with reason, that a battle will have to be fought with the District Railway and the omnibus companies, but they believe that their scheme would so greatly add to the convenience of the public that Parliament will not feel justified in refusing to allow them to proceed.

Bath.—Mr. F. H Tulloch, Local Government Board inspector, has held an enquiry respecting the application of the Bath Urban Sanitary Authority to borrow £58,000 for the purposes of electric lighting Mr. R. A Moger (deputy clerk to the Bath Urban Sanitary Authority) reviewed the conditions under which the electric light was established in Bath and the negotiations which led to the authority being granted a provisional order by the Board of Trade for carrying out the work of electric lighting. There was a clause in that order, he explained, that the authority should purchase the undertaking, and the Board of Trade would not cancel the license of the company until the purchase of the works had been agreed upon. The valuation of the concern by the independent valuer appointed by the Board of Trade was £24,500, and the Corporation agreed to purchase at that price Agreements had been entered into and sealed by the company and the authority, but as far as the authority was concerned, it was subject to the sanction of the Local Government Board to the loan. Forty-five thousand pounds was the amount it was originally intended to ask for, but the committee thought further extensions than those Mr. Hammond originally suggested were necessary, and that occasioned £13,000 additional being asked for. The authority did not consider it would be a burden on the rates, but rather a help to them. Alderman Sturges, chairman of the Electric Lighting Committee, said there was no division on this subject until the additional £13,000 was asked for. It would be necessary, in order to make the works a success, to have more powerful engines, dynamos, and electrical apparatus. They were not going to extend mains until they received a guaranteed income from consumers which would represent 10 per cent. on the outlay. Mr. Hammond, the consulting electrical expert, observed that there were two issues—first, as to the advisability of acquiring the works of the company, and then as to making extensions. He believed all the ratepayers would be unanimous in their desire to take over the electric light if they felt convinced the profit would not only be sufficient to pay interest and sinking fund, but leave a margin to make a reduction in the rates. Any opposition must be from those who thought the Corporation would not be in pocket sufficient to pay the annual charges, and that it would mean a call upon the rates. Continuing, Mr. Hammond said all the data in connection with electric light works showed that they were prosperous. At the present time the works under statutory powers in operation numbered 106, 60 of which were now in the hands of local authorities, and there were some 30 works in course of construction, 22 of which were being put up by local authorities. Mr. Hammond went on to give details of the proposed expenditure, explaining why an expenditure of £58,000 was now proposed instead of £45,000, as set out in the first application to the Local Government Board. The amount of the purchase of plant and works, etc., was £24,535, of which £1,800 was in accordance with Mr. Wilcox's estimate for the land. The sum of £22,735 remaining was the award of Prof. Kennedy. As to the advisability, having acquired the works, of immediately spending a large sum in extending, he drew attention to the fact that, under the provisional order, they were under certain obligations to supply residents throughout the city. The sets of plant at present used were about filled up, and if they did not immediately approach this question of extension it would be utterly impossible for them to supply sufficient electrical energy to meet the demands of the consumers next winter. On the necessity of some extension of the works he urged that there really could not be two opinions. The question arose as to what form the extension should take, and he proceeded in detail to justify the extension proposed by the Electric Lighting Committee. The whole capacity of the Bath electric lighting works was 10,000 lights, and when they put in the three sets of plant which was proposed they must always have one set in reserve. Therefore they would not be able to turn on more than 20,000 lights. Originally he put down £4,650 for cables and transformers—£3,000 for the former and £1,650 for transformers and chambers which it was proposed to place in Milsom-street and Union-street. When the committee came to consider the £4,650, they were confronted at once with the difficulty that under the order anyone could demand the light, and they thought they had better make a large provision. They prepared a long list of streets, the total distance being 21,495 yards. The Corporation might find such a general demand that these mains might be required within the next few months, or they might find that the call for the mains would be delayed. In either case they thought the proper policy at the present time was boldly to face the expenditure. The total sum put down for extensions was £12,455; £7,985 was for cables (high and low tension); £470 for transformers and chambers; provision for making good pavements, £1,000; underground work in connecting new customers, £600; meters and transformers in the outside area, £2,400. He averaged the price for private lighting at 5½d. per unit, which was by no means high, and equal to about 3s. per 1,000 for gas, the price in Bath being 2s. 6d. With the plant full up they would supply about half a million units per annum, and that would realise £9,285, while from the public lighting £2,110 would be received, making a gross revenue of £11,945. In Leeds the cost of production was 2·05d. per unit. It might be said coal was cheap in Leeds; so it was, but if they

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trebled the cost of coal at Leeds the cost came to 2·65d. He put the cost for Bath at 2½d. per unit. He put the interest and sinking fund on £58,000 at 5¼ per cent., making the annual charge £3,045, and, after allowing £1,000 a year for depreciation, there would be a margin of £1,651. Mr. Metzger gave figures showing the increase of business done by the electric lighting company. At the present moment they had 12,000 lights connected, and they had been obliged to refuse many applications because they had not the power at the works to supply more lights. In 1895 the company made a gross profit of £1,570 on a capital expenditure of £39,000, and they could have paid a 4 per cent. dividend, but it was decided to keep it in hand. This year, up to the end of October, the net profit had been £700, and in the next two months they would make £700 more. The chances were that when the light was extended outside the present radius the profit would be increased. Of the present 161 consumers 138 were shops; they had two churches, but five churches would not be equal to one public-house. Another church had just applied for the light, but it was outside the present area. The Inspector intimated that he had a doubt as to whether so large an amount for extensions was required at present, but he would consider the point.

PROVISIONAL PATENTS, 1896.

OCTOBER 26.

23743. Improvements in dynamo-electric machines. George Cheffey-James and Harry Percy Ward, 25, The Nook, Barber-road, Sheffield.

23778. Improvements in electric indicators of water-level. John Ernest Hutton, 28, Southampton-buildings, Chancery-lane, London.

23805. Improvements in or in connection with incandescent electric lamps. Frederick Adolph Max Naumann (commonly known as A. Norman), 6, Lord-street, Liverpool.

23816. Improvements in conduit tubes more especially suitable for electrical conductors. Edward Hibberd Johnson, 45, Southampton-buildings, Chancery-lane, London. (Edwin Truman Greenfield, United States.)

OCTOBER 27.

23827. Improvements in and connected with electrical storage batteries. Edward William Bonson, 54, Bellefields-road, Brixton, London.

23871. Improvements in and relating to commutators and collectors for dynamo-electric generators and electro-motors. Charles Henry Wade, James Moores, and Henry Oliver Farrell, 70, Market-street, Manchester.

23942. Improvements in or relating to electric switches or circuit breakers. Reginald Belfield, 322, High Holborn, London. (Alexander Jay Wurts, United States.)

OCTOBER 28.

23980. Improvements in electric stop-motion drawing frames for fibrous materials. Frank Arrowsmith, 33, Brazennose street, Manchester.

23992. A new system of electrical propulsion for cycles and common road and other vehicles. Robert Alfred Marples, 24, Temple-row, Birmingham. (Complete specification.)

24019. Improvement relating to electric batteries. Louis Jules Hippolyte Rochatte, 11, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, April 21, 1896, being date of application in France.)

24062. Improvements in or relating to brackets or holders suitable for electric lamps and the like. William Sumner, 46, Lincoln's-inn-fields, London.

OCTOBER 29.

24075. Improvements in suspenders for electric lamps. Thomas Laurie, Wellside-terrace, Falkirk.

24084. Improvements in or applicable to switches for electro-motors and the like purposes. Joseph Platt Hall and William Henry Seville Craven, 70, Deansgate, Manchester.

24152. Improvements in signalling apparatus for electric railways or tramways. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Homer Alton Parrish, United States.) (Complete specification.)

OCTOBER 30.

24177. Improvements in and relating to dynamo-electric generators. Charles Henry Wade, James Moores, and Henry Oliver Farrell, 70, Market-street, Manchester.

24178. Improvements in and connected with magneto and dynamo electric machines. Charles Henry Wade, James Moores, and Henry Oliver Farrell, 70, Market-street, Manchester.

24190. Improvements in electrolier ceiling fittings. Harry Dain Hinks, 12, Cherry-street, Birmingham.

24220. Electric lamp for cycles or other carriages and any other purpose. Alexander Riddell, 97, Fleet-street, London.

24223. Improvements in electric switches. Isaac Henry Storey, Herbert Lushington Storey, and Joseph Parkinson, 5, Market-street, Manchester.

24235. An improved electric lamp. David Forbes, 321, High Holborn, London.

OCTOBER 31.

24291. Improvements in electric burglar alarms. William Harrison Ward, 89, Chancery-lane, London.

24348. Improvements in fittings for electric and other lighting. Charles Edward Bulling, 4, South-street, Finsbury, London.

24350. Improvements in reflectors for electric lamps. Richard Jones 170, Askew-road, Shepherd's Bush, London.

24351. Improvements in or relating to electric railways. A. H. Brunn, Viktor Takács, Louis de Reymond-Schiller, and Philipp Westphal, 322, High Holborn, London. (Complete specification.)

24367. Improvements in conduits for electrical conductors. Erwin Lavens, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1895.

19130. Chemical substance and the application thereof to industrial purposes such as rubber, guttapercha, or celluloid substitutes, insulations of electrical conductors, coverings for ships' bottoms, or wall and floor coverings. Castle.

20926. Block systems for electric railways. Belfield.

21679. Means for use with electric cables for diverting the current through adjacent cables when required for repairs or other purpose. Edmunds.

22028. Protective coverings for the joints of electric cables. Hardingham. (Felten and Guilleaume.)

22252. Direct electric current transformers or motor generators. Blackburn and Boyden.

22732. Process and apparatus for the electrolytic production of metallic zinc from ores of zinc and metallic zinc and metallic copper from zinc ores containing copper, and the production of oxygen gas in the cases specified. Burghardt and Rigg.

1896.

9048. Electrical fog-signalling apparatus for railways. Tomlins and Gurr.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	8¾-9¼
Brush Company, Ordinary	3	¾-1¼
——— Non. Cum., 6 per cent. Pref.	2	1-1¼
——— 4½ per cent. Debenture Stock	100	110-113
Central London Railway, Ordinary	10	10-10½
———	2	4-4½
Charing Cross and Strand	5	9½-10
Chelsea Electricity Company	5	7¾-8¼
——— 4½ per cent. Debentures	100	114-117
City of London, Ordinary	10	16-17
——— 6 per cent. Cumulative Pref.	10	17-18
——— 5 per cent. Debenture Stock	100	130-135
City and South London Railway, Consolidated Ordinary	100	50-52
——— 4 per cent. Debenture Stock	100	135-137 xd
——— 5 per cent. Pref. Shares	10	15-15½
County of London and Brush Provincial Co., Ordinary	10	8½-9½
——— 6 per cent. Cum. Pref.	10	13¾-14¼
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
Edison and Swan United Ordinary	3	1¾-2¼
——— 4½ per cent. Debentures	100	103-106
Electric Construction, Limited	2	1¼-1¾
——— 7 per cent. Cumulative Pref.	2	2½-3
Elmore's Copper Depositing	2	¼-¾
Elmore's Wire Company	2	¼-¾
W. T. Henley's Telegraph Works, Ordinary	10	17-18
——— 7 per cent. Preference	10	18½-19½
——— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	3¾-4¼
——— 7 per cent. Preference	5	8½-9½
India Rubber and Gutta Percha Works	10	21-22
——— 4½ per cent. Debentures	100	105-108
Kensington and Knightsbridge Ordinary	5	9½-10
——— 6 per cent. Pref.	5	8¼-8¾
Liverpool Electric Supply, Ordinary	5	8-8½
Liverpool Overhead Railway	10	13¾-13¼
——— 5 per cent. Pref.	10	17¼-17¾
——— 4 per cent. Mortgage Debentures of £100	100	112½-114½
London Electric Supply	5	¾-1¼
Metropolitan Electric Supply	10	13-14
——— 4½ per cent. First Mortgage Debenture Stock	100	121-124
National Telephone, Ordinary	5	7¼ 7¾
——— 6 per cent. Cum. First Pref.	10	17-19
——— 6 per cent. Cum. Second Pref.	10	17-19
——— 5 per cent. Non. Cum. Third Pref.	5	6½-7
——— 3½ per cent. Deb. Stock	100	106-109
Notting Hill Company	10	11½-12½
Oriental, Limited, £1 shares	1	1¾-2
——— £5 Shares	5	8½-9
——— £4½ shares	4½	7½-8
Oriental Telephone and Electric Company	1	⅜-⅝ xd
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	103-105
Southampton Electric Company	5	4¾-5¼
St. James's and Pall Mall, Ordinary	5	12-13
——— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	39-42
——— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	—	7¾-8¼
Westminster Electric Supply, Ordinary	5	10½-11½
Yorkshire House-to-House		7½-8

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NOTES.

The Submarine Telegraph Memorial. — The general committee have confirmed the decision of the sub-committee to put off the question of a memorial of the establishment of submarine telegraphy until 1901, and meanwhile to go on with a memorial to Sir John Pender.

Fused Zinc Chloride.—According to the determinations of Richard Lorenz, published in the *Zeitschrift für Inorganischer Chemie*, the E.M.F. required to decompose "pure" fused zinc chloride is about 1·5 volts. The theoretical voltage should be more like 2, but there is the high temperature to be considered.

Oxygen.—It is reported from America that the cheap production of oxygen on a commercial scale has been solved, and that oxygen gas is being manufactured at 3d. per 1,000ft., which, if true, may have very far-reaching effects. This appears to be the old manganese dioxide process over again, which has always hitherto failed on a practical scale.

Books Received.—We have just received from E. and F. N. Spon, 125, Strand, "The Commercial Organisation of Factories," by Mr. J. Slater Lewis. Time has failed to allow us to do more than glance at a mysterious diagram opposite the title-page, and therefore further notice of the book must be reserved for the present. From the same publishers we have Mr. F. J. Britten's "Watch and Clockmakers' Handbook" (ninth edition).

For Those Away.—Last Sunday, when Canon Fleming was preaching at St. Michael's, Chester-square, what seemed to be two Bibles instead of one on the desk of the pulpit arrested the attention of the congregation. But just before his discourse the preacher announced that it was no second book on his desk, but that the Telephone Company had placed there a transmitter by which the discourse could be laid on to the hospitals and to subscribers who were unable to come to church.

Amalgamating Zincs.—Mr. Oppermann's way of amalgamating battery zincs is stated by the *Elektrochemische Zeitung* to give good results. To a nearly saturated solution of neutral sulphate of mercury in water a quantity of sulphuric acid is added to obtain complete solution. Oxalic acid is added and a little sal-ammoniac. The zincs are dipped into this, rubbed, and dried. In this roundabout way of going to work it does not seem clear where the saving comes in.

The Civil Engineers.—At last Tuesday's meeting the papers taken were those by Mr. G. E. W. Cruttwell and Mr. S. G. Homfray on the Tower Bridge and its lifts. The subject is obviously one rather outside the range of the electrical branch of the profession, but it is of interest to note that the bridge has been opened on an average 18 times daily, and on one occasion the bascules were raised as many as 12 times in two hours. The papers will be discussed next Tuesday, November 17.

A Combination.—If there is any electrician who is anxious to try his hand at looking after mad people there is an opening for him at the Three Counties Asylum at Hitchin. For "acting as electrician" he will be allowed the "further sum of £10 per annum" in addition to £27 per annum, his wages as a ward attendant. One would not imagine that the occupation of a lunatic attendant was such an attractive one that any man that had a good trade would care to take it up; and when the asylum gets its electrician, the extra £10 will probably be about the value of his electrical services.

The Cable Conference.—There was a meeting of the Anglo-Colonial Cable Conference on Monday at the Colonial Office. The meeting was informal, and there were present Lord Selborne, chairman; Mr. G. H. Murray, C.B., of the Treasury; Sir Donald Smith, Sir Mackenzie Bowell, and Mr. A. G. Jones, of Halifax, representing Canada; Sir Saul Samuel and Mr. Duncan Gillies as representing Australia; and Mr. Mercer, secretary. There was another meeting arranged at the Colonial Office to take evidence. The proceedings were in both cases private.

Imperial Institute.—A lecture was delivered at the Imperial Institute on Monday evening by Prof. Wyndham Dunstan, F.R.S., the recently-appointed director of the Scientific and Technical Department of the institute, on some of the work of the department. Sir Joseph Lister, president of the Royal Society, was in the chair. Prof. Dunstan explained that the department was now provided with large and well-equipped laboratories at the institute, and that there was a staff of skilled chemists now at work investigating. At the close of the lecture the laboratories were open for inspection.

Coming Events.—The Physical Society meet this (Friday) afternoon (Burlington House, five o'clock). Tomorrow (Saturday) is the Motor Car Club meet at the Hotel Metropôle (10.30).—The Civil Engineers on Tuesday, 17th, discuss the papers on the Tower Bridge.—On Wednesday is the opening address by Major-General Sir Owen Tudor Burne at the Society of Arts (8 p.m.).—On the same evening the Meteorological Society meets at 7.30 p.m. at the Civil Engineers', Great George-street (Mr. Ellis, on "The Meteorological Conference," and the Hon. Rollo Russell, on "Haze, Fog, and Visibility"). Next Friday (20th) the cycle show, including motors, opens at the Agricultural Hall, Islington.

Dimensions of Electric Units.—Mr. Joubin has communicated to the French Physical Society a note on the dimensions of electric and magnetic quantities. Starting with the assumption that the dimensions must be integral powers (positive or negative) of the fundamental units of length, mass, and time, Mr. Joubin says there are 12 possible combinations for K, of which only one can have a mechanical signification attached to it. He finally brings out the dimensions of the electric field as a pressure or tension, the magnetic field a velocity, the current density an angular velocity, and so forth. Which is the necessary result of the identity in form between the equations for elasticity and the electromagnetic field.

The Telephone Service.—The people that used to write letters to the *Times* complaining of the telephone service have apparently transferred their correspondence to the *Daily Telegraph.* The complaints are of the usual character, and involve both the trunk lines and the Telephone Company's exchanges. As, however, it appears from an interview given to a representative of the *Daily Telegraph* by the National Telephone Company's manager that the company considers that as regards the London service there is little or nothing to complain of, it is obvious that a good deal more than mere letters to a newspaper will be necessary before much is done to remedy the faults that must lie at the bottom of these constant complaints.

The Royal Society.—The following is a list of those who have been recommended by the president and council of the Royal Society for election into the council for the year 1897 at the anniversary meeting on the 30th inst.: President—Sir John Lister; treasurer—Sir John Evans; secretaries—Prof. Michael Foster, M.D., Prof. Arthur William Rücker; foreign secretary—Edward Frankland;

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other members of the council—Prof. William Grylls Adams, M.A., Prof. Thomas Clifford-Allbut, M.D., Prof. Robert Bellamy Clifton, William Turner Thiselton Dyer, Prof. James Alfred Ewing, Lazarus Fletcher, Walter Holbrook Gaskell, M.D., Prof. Alfred George Greenhill, M.A., William Huggins, Prof. Charles Lapworth, LL.D., Major Percy Alexander M'Mahon, R.A., Prof. Raphael Meldola, Prof. William Ramsay, Lord Walsingham, Prof. Walter Frank Raphael Weldon, and Admiral William James Lloyd Wharton.

Glow-Lamp Tests.—The reference of the commission on incandescent lamp standards of the German Association of Electrical Engineers (Verband Deutscher Elektrotechniker) has been published in the *Elektrotechnische Zeitschrift*. It relates to lamps for voltages of 60 to 70 and 95 to 125, with an efficiency of three to four watts per candle, and a power of 10, 16, 25, and 32 candles. All these are German "candles"—in reality the Hefner lamp, and possibly slightly under the British candle. In testing, lamps are considered as done with when their light-giving power has fallen 20 per cent. below that specified at the assigned voltage. Conditions are given under which the sub-commission undertake the tests, and a blank form of guarantee to be given by the lamp manufacturers is set out. A reference is provided to the Reichsanstalt in case the correctness of a test is disputed. The Edison socket was recommended for ordinary use.

Voice-Production Extraordinary. — America is the classic land of "wildcat" notions, but the following imported from the *New York Journal* by our own *Daily Mail* is a decided novelty. It is nothing less than to secure "compass" and effect in singing by artificially contracting the vocal chords under the influence of electric stimulation. There is just the possibility of a resultant scream. The question of its relative unpleasantness to the hearer and the executant need not be considered, as the process is not likely to get beyond the first rehearsal. Yet the *Daily Mail* thinks the notion worth nearly a column, with an illustration, quite as though the thing were an established success. It seemed reasonable to hope that as electricity got more common, and people got more familiar with it, they would cease to talk, write, and believe so much nonsense about it. But there is more electricity in America than in England—and more nonsense. It is not hopeful.

St. Elmo's Fire. — Further observations on the phenomena of a brush discharge into the air observed at sea, and sometimes, though more rarely, on land, have been published by the *Deutsche Seewarte*. The classification of recorded observations of the phenomenon has been made by Mr. Halbermann. In about 77,000 ship-days of observation the St. Elmo's fire was noted 164 times. The greater frequency of the phenomenon at sea is explained by the fact that on land there are almost always a large quantity of points capable of determining a discharge, and therefore it seldom attains a sufficient density to give a noticeable glow. Cognate to this subject is a curious story told by the *Zeitschrift für Elektrotechnik* of how an agricultural labourer, who was going with a horse and cart down a country road between wire fences, was followed for some seconds by a ball of fire and frightened by a blue light and crackling sound from the wire fences. There is no record of a thunderstorm at the time anywhere near, but the weather is stated to have been variable and rainy.

Integrity of Cables.—Speaking of the pending trial between the United States and Hayti Cable and Telegraph Company and the Compagnie Française des Cables Télégraphiques, *Le Soleil* fears that all submarine communications of the world being in English hands may prove a source of considerable power to England in case of war, and urges that all attempts made by French enterprise to battle against this ought to be encouraged and supported. Without the French to tell us of it, we English should never be able to realise the deep-laid cunning with which in spite of our deficiencies, we maintain our position against the rest of the world. Up to the present we have been believing that there was serious danger as to the integrity of our telegraphic communications in time of war, and that there was not much use in the capital and direction of the cable company being English if the cable is landed on a possibly unfriendly shore, or even if it is laid in shallow waters along foreign shores where the finest fleet in the world could not guarantee it from mischief at the hands of a hostile cruiser.

Fire Brigades.—The officers of the provincial fire brigades who had taken part in the Lord Mayor's Show dined at the Holborn Restaurant on the 9th, Captain Shean presiding. Captain Dyson, replying to the toast of "The Fire Service," proposed by Mr. Arnold, complained that there were certain defects in the law which were greatly detrimental to fire brigade work. Members of the service could not be put into electrical communication with the fire stations, and it was proposed to bring this matter before Parliament next session if possible. Their brigades were deficient in appliances for dealing with fires upon premises where electricity was largely used, and they might with advantage follow the lead of America in this respect. A little elementary knowledge of what to do with wires carrying a current of any magnitude would do no harm in the officers of a fire brigade, but unless many of the tales that are told in America are grossly untrue, some of the brigades there seem to have succeeded in remaining wonderfully ignorant on the subject, considering the frequency of fires and overhead wires in that country.

Acetylene.—The investigations of Messrs. Berthelot and Vieille on the conditions of the explosibility of acetylene unmixed with air were referred to last week. According to the account of the researches in the *Comptes Rendus* of the Académie des Sciences, it would appear that though liquid or highly compressed acetylene in steel bottles is violently explosive when detonated, the investigators were unable to bring about explosion by any mere mechanical shock unless the latter was carried so far as to break the bottle and liberate the gas into the air. The investigators have an hypothesis to account for this last result. At ordinary pressures acetylene would appear to be safe if unmixed with air, and in small quantities absolutely safe. It is, however, suggested that if carbide of calcium is attacked by small quantities of water, ignition (presumably of the mixed acetylene and air) may result from local overheating, and various precautions are suggested as to the manufacture and manipulation of the highly compressed gas. The investigators are throughout favourable to the extended use of acetylene, and do not think that the possibility of danger should be allowed to restrict this.

Secondary Education.—Sir Henry Roscoe has written to the *Times* to enforce a point of some importance in any scheme for organising secondary education. It is that while primary education covers much the same subjects for all, secondary education requires to be specialised to meet individual or, if we may say so, "district" wants. "The children of the Dorset peasant and of the Manchester mechanic require different treatment, and here specialisation and local requirements come in. Hence it is that, whilst decentralisation and local authority are the watchwords for secondary, a uniform system and centralised authority are the principles upon which our primary education has rested and ought still to

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rest." Without being quite so confident as Sir Henry Roscoe as to the absolute perfection of our primary education, it is impossible not to see that his principle is right, though the way of giving effect to it may prove untrustworthy. The official mind always tries to run things in a uniform groove, because this makes matters easy and safe, and allows of inspection examinations, while the public is caught by the apparently businesslike notion of "payment by results." In another field there can be little doubt that it is to the comparative, not to say competitive, independence of the German universities in the past that much of the scientific progress of that nation has been due.

Accidents Abroad.—According to a telegram from Calais, an extraordinary accident took place last week at Tourcoing. A boiler 15ft. in height was being conveyed through the town, 16 horses drawing it. Two men were set to keep the overhead wires clear, but allowed them to come in contact with the boiler. Immediately the horses were struck down, some being killed, and the workmen received violent shocks. If the tale is true, there would seem to have been great carelessness somewhere, but it is by no means easy to gather from the telegram what occurred. The boiler appears to have been carried on a trolley of some sort. The Brussels correspondent of the *Pall Mall Gazette* is responsible for a tale of how, in the Place du Théâtre at Liège, a woman, "catching her foot in a coil of electric wire connected with the theatre and the electric tram system, fell to the ground, and received a succession of shocks. Several passers-by attempted to pull the woman clear, but themselves received a shock. An officer attempted to cut the wire with his sword, but was prostrated by the current he received. As a last resort several men wrapped their hands in bandages, and thus protected succeeded in rescuing the sufferer." It is difficult to understand how "live" wires and uninsulated could be left about the ground in coils. In fact, both narratives as they stand require to be taken with a certain amount of reserve.

Cryptoscope Screens.—In *L'Elettricità* there is given an account of a note presented by Prof. E. Salvioni to the Accademia Medico-Chirurgica of Perugia on the subject of the comparative value of various salts for the purpose of fluorescent screens for Röntgen ray work. The method of comparison adopted consisted essentially in varying the density of the radiation received by changing the angular direction of the screens—*i.e.*, making the rays fall at a more or less oblique angle on the screen. When the two screens give an apparently equal illumination the relative efficiency of the fluorescent salt is immediately determined by the angle between the screen and the direction of the ray. (This looks open to several errors, but it is stated that experience shows it to be reliable.) The results are given for various substances to four significant figures, a degree of precision which is obviously altogether out of the question in photometric work of this kind. In fact, different samples of barium platino cyanide differ by 40 per cent. Potassium platino cyanide would appear to be about half as effective as the barium salt weight for weight, and sodium and calcium platino cyanides less than a quarter. The power of tungstate of calcium and ammonium-uranyl fluoride comes out as about a twentieth of the best sample of barium platino-cyanide. The American suggestion of oxide of zinc was not tried. Probably very different results would be obtained with a different tube and voltage, and experiments in this direction and also as to the differential absorption of different screens are promised.

The Junior Engineers.—The inaugural meeting of the Institution of Junior Engineers' sixteenth session was held last Friday at the Westminster Palace Hotel, the chair being taken by the retiring president, Mr. A. Denny, M.I.N.A., of Dumbarton. The preliminary business included the announcement of the admission of 28 new members, the presentation of the institution premium to Mr. F. J. Bancroft, of Hull, for his paper on "The Stability of Tall Chimneys," and a cordial vote of thanks to Mr. Denny for his services as president, which was proposed by Mr. H. B. Vorley, chairman of the institution, and seconded by Mr. E. Berry. Mr. Denny then introduced the president-elect, Mr. A. R. Binnie, M.I.C.E., who proceeded to deliver his presidential address. After referring to the beneficent character of the work of the engineer, mention was made of the varied nature of the subjects of which he should have some knowledge in the intelligent and successful execution of his duties. The principal portion of the address was devoted to considerations with respect to some of the ways in which water enters into and demands the professional attention of the engineer. On the motion of the vice-chairman of the institution, Mr. Basil H. Joy, seconded by Mr. Ernest King, a hearty vote of thanks was passed to Mr. Binnie for his interesting address, and the proceedings terminated with the announcement of the ensuing meeting on Friday, December 4, when a paper would be read on "Electric Central-Station Working," by Mr. P. W. McDougall, A.I.E.E., of Deptford.

Society of Arts.—The opening meeting of the one-hundred-and-forty-third session of the Society of Arts will be held on Wednesday evening, November 18, at 8 p.m., when an address will be delivered by Major-General Sir Owen Tudor Burne, K.C.S.I., C.I.E., chairman of the council. For the other meetings before Christmas the following arrangements have been made: November 25—W. Worby Beaumont, M.I.C.E., "Mechanical Road Carriages." November 2—W. A. S. Hewins, M.A., "The Teaching of Economics." December 9—Bennett H. Brough, A.R.S.M., "Mining at Great Depths." December 16—Arnold Dolmetsch, "The Chamber Music of Purcell, Handel, and Bach." For subsequent meetings the following papers have been promised: by Messrs. R. Brudenell Carter, "Children's Sight"; Edward R. Calthorpe, "Light Railways"; George Lacy Hillier, "Cycling—Historical and Practical"; George Cullow, "Line Engraving"; Leon McCulloch, "Lithography"; W. H. St. John Hope, M.A., "Heraldry"; and M. J. R. Dunstan, M.A., F.R.S.E., "Dairy Produce." The Cantor lectures will be by Prof. Vivian B. Lewes, "The Use of Gas for Domestic Lighting" (three lectures, beginning November 23); Mr. William Burton, F.C.S., "Pottery" (four lectures, January 18); Mr. C. F. Cross, F.C.S., "Cellulose" (three lectures, February 15); Prof. W. Chandler Roberts-Austen, C.B., F.R.S., "Alloys" (four lectures, March 15); and Mr. Lewis Foreman Day, "Lettering" (four lectures, May 3). The Howard lectures will be by Prof. J. A. Ewing, M.A., F.R.S., on "The Mechanical Production of Cold" (six lectures, beginning January 28).

Patent Agents.—The annual general meeting of the Society of Patent Agents took place at Anderton's Hotel, E.C., on Wednesday night, the presidential address being delivered by Mr. J. Sinclair Fairfax. It was commendably short. The expense of patent litigation was dealt with and the anomalous position of the expert witness. Mr. Fairfax expressed a fear that unless something was done a new profession would arise—namely, that of expert witnesses, whose fees would be immense, and who would be practically sworn advocates. These witness-advocates would tell the truth, but the eminent barrister who examined them might arrange that they did not tell

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the "whole truth," and the judge, unless an expert, would be unable to detect and check this. As a remedy it was suggested that much of the preliminary work before coming into court should be transferred to the Patent Office, and the evidence of the experts taken on affidavit, leaving it for the judge, with or without assessors, to decide points of law only after the facts had been threshed out. In the discussion that followed, general dissatisfaction was expressed with the state of patent litigation, though it was suggested that the evils complained of, and particularly that the issue was too often at the mercy of the longest purse, were common to all law in all countries. It may, however, be doubted if they do not exist in a somewhat higher degree in patent litigation than in general practice. One curious suggestion made was that, to meet the difficulty of a patentee getting a capitalist who necessarily knew nothing of the matter to take up his invention, a "court" ought to be instituted which would examine any invention and give a "certificate of merit." The expert would come in here again, only apparently the Government would have to pay him instead of the inventor.

Motor Car Club.—There has been a considerable amount of expectation as to the turn-out to be made at the Motor Car Club's meet to-morrow (Saturday) at the Hôtel Metropole, and given reasonable weather it is a safe prediction that there will be a crowd. The arrangements are that the motorcars shall start from Whitehall-place at 10.30, Mr. Harry J. Lawson, president of the club, leading the way. Crossing Westminster Bridge, the cars are to go in procession and at a slow speed as far as Brixton, from which point they will be free to take their own routes to Reigate, where a stoppage of an hour is allowed for luncheon. When the foremost cars have reached Preston Park, on the outskirts of Brighton, they will halt for some time in order that as many as possible of the others may overtake them and enter the town in procession. In view of the certainty that there will be many more guests invited to the meet than could be seated on the cars, the club has arranged to run a special train from Victoria to Brighton at 11 a.m., and this train will stop at Reigate on the way down so that passengers by it may witness the arrival and departure of the cars and proceed to Brighton in ample time to see them enter the town. As many as 54 motorcarts have been entered for the meet, and it is believed nearly all of them will be brought out. After two cars belonging to Mr. Harry J. Lawson will come the two Daimler cars which finished first and second in the race from Paris to Marseilles and back six weeks ago, and the muster will include 16 other Daimler cars, six electric carriages, three Pennington carriages, two Bollées, and three Dions. Besides these there are to be five Arnold carriages (made in Germany), four Anglo-French motors made in England, and two Durya motors from America, besides private cars belonging to the Hon. Evelyn Ellis and the Hon. C. Rolls.

Magnetic Photographs.—When the Röntgen ray excitement was at its height various observers found that in certain cases when a magnet had been left in close proximity to a sensitised photographic plate a sort of image was obtainable on development even when there had been no possible access of light. Those observers who were at all shaky in their physics naturally thought the magnetism had something to do with it, a confusion of ideas which was not diminished by the practice of expressing the magnetic circuit in lines of force. Although this was obviously impossible, the nature of the action was not in all cases explicable either by the influence of difference of temperature, pressure due to the magnet, or the presence of stray light, and as a matter of fact remained unexplained. A photographic plate as now manufactured is such a sensitive affair that almost anything will affect it, as many photographers who have wrapped them up in the wrong sorts of paper have found to their cost, and it would now appear that the infinitesimally small amounts of vapour emitted by metals at ordinary temperature are capable of affecting a photographic plate. Mr. Henri Pellat some years ago showed that the presence of steel would affect such a plate even when separated from it by a sheet of cardboard or any substance which is not impermeable to vapour. Much more marked effects have been obtained by Mr. R. Colson from more volatile metals, such as zinc, magnesium, and cadmium, provided the surface of the metal is first polished to remove the coating of oxide, and it is even suggested that the process might be of practical use. No results were obtained from lead, tin, copper, or aluminium, but that, of course, only goes to show that the vapour did not react on the plate, not that there was none. It should also be added, in view of Mr. Pellat's result, that so far as they went Mr. Colson's experiments gave no result with iron.

Motorcarts.—In connection with the exhibition of motor carriages at the Crystal Palace the following awards have been made: Diploma for gold medal—C. C. Burrell and Sons, for light compound traction engine; Emile Delahaye, for benzoline carriage; Mons. Serpollet, for steam carriage; the Steam Carriage and Wagon Company, for steam van. Diploma for silver medal—Société Franco-Belge, for steam brake; L'Hollier, Gascoigne, and Co., for benzoline carriages. Diploma for bronze medal—Arnold's Motor Carriage Company, for benzoline carriage. The report by the jurors is signed by W. Worby Beaumont, M.I.C E.; Walter Hancock, M.I.E.E.; H. A. O. Mackenzie, C.E.; and Alf. R. Sennett, A.M.I.C.E., hon. executive commissioner. "Although none of the vehicles exhibited approached that degree of perfection which would place them beyond adverse criticism," the jurors consider the prospects of benzoline motorcarts hopeful, and of steam motorcarts more hopeful. As to electric carts, "the jurors considered it matter for regret that no electrically-propelled vehicle had been submitted for trial." In fact, not having seen them they cannot well say. The motorcart in the Lord Mayor's Show on Monday behaved very nicely. The oil-engine is warranted not to bolt or shy, but it is not altogether clear that it may not possibly jib. This one did not. The crowd received it with approval and the horses treated it as beneath their notice. So far the oil motorcart has been having all the honours, but if it is true as stated, that as an immediate result of the new Motor Act coming into effect on Saturday arrangements have been made by the London Electrical Cab Company to place a large number of electrical cabs almost immediately for hire in the streets of the Metropolis, we shall see something in a week or two. But we must confess that we should have more confidence if communications of this sort were made to the technical as well as to the daily Press.

London Chamber of Commerce.—The chamber have arranged with Major S. Flood Page to deliver an address on "Motor Vehicles" in the council-room of the chamber on Tuesday, December 1, at 3.30 p.m. The chair will be taken by Mr. W. H. Willans (chairman of the council). In a circular to members it is stated that, in reference to code telegraphy, last year most vigorous opposition was offered by the chamber to the obligatory application to code telegrams of an official vocabulary of code words drawn up by the International Telegraphic Bureau of Berne, and which it was intended to enforce at the beginning of 1898 in respect of European code messages. "A general and detailed criticism was

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made of the vocabulary, and the support of Continental as well as of home chambers was sought, with gratifying success, in representations to the telegraph administrations urging the withdrawal of the vocabulary or the extension of the period before its application pending radical revision," and when the International Telegraphic Conference assembled at Budapest it was decided to prepare a second edition of the vocabulary to include all the words obtainable from the eight authorised languages of not less than five nor more than 10 letters or Morse telegraphic signals, and to postpone the enforcement of this revised vocabulary to a date to be fixed by the next conference in 1901. In its protest against the application of the vocabulary to European code messages, the chamber was careful also to object strenuously to the application of any vocabulary to extra-European code messages. From a communication received from the Berne office it is, however, quite evident that the intention is eventually to prescribe extra-European code messages in the same way as European code messages, but until the revised or second edition of the vocabulary is available the past opposition in this respect will be continued. "The council are thus able to report that their action has been very successful in regard to the most essential objections, and they have conveyed their thanks to the home and Continental associations who co-operated in securing proper attention to the question." As to English telegrams, in a reply, under date October 31, to representations made by the chamber in favour of various postal and telegraphic reforms, on behalf of the Postmaster-General, it is stated: "With regard to the charging of commercial terms in telegrams, his Grace directs me to say that both in inland and foreign telegrams it is the practice to count the terms 'cif' and 'fob' as one word, but they must be written in small letters and without stops." Lastly, as to the metric system. The council "note with satisfaction that a Bill has been prepared (and was introduced towards the end of the last session of Parliament) by the President of the Board of Trade to render the use of metric weights and measures permissive in the United Kingdom, and providing for the verification of such weights and measures by Board of Trade standards. As the law at present stands, the use of these weights and measures is prohibited for purposes of trade, and it is largely at the instance of the chamber that this anomaly is to be removed. It is intended, therefore, to heartily support this permissive measure in the ensuing session, leaving for future effort the compulsory introduction of the system, as was recommended by the Select Committee of the House of Commons."

Solution and Electrolysis.—In the October number of the *Philosophical Magazine* Prof. Poynting endeavours to explain the phenomena of the osmotic pressure of solutions by the hypothesis of chemical combination between the solvent and the dissolved matter. Any successful theory of solution must explain the fact that the osmotic pressure follows the laws of gaseous pressure, and has the same absolute value as that of the pressure which the dissolved molecules would exert in the gaseous state when filling a volume equal to that of the solution. Whatever be the ultimate cause of the osmotic pressure, the gaseous laws must be obeyed by dilute solutions, as the molecules of any finely divided matter must be in general out of each other's sphere of influence, so that each will produce its effect independently of the rest. This is all that is necessary for Boyle's law and Avogadro's law to hold, so that these, as well as the mere existence of osmotic pressure, are explained by chemical combination just as well as by molecular bombardment. On the other hand, no good reason has been hitherto given why chemical forces should be so adjusted that the osmotic pressure of the dissolved molecules should have the same absolute value as that of the pressure which the same number of gaseous molecules would exert when filling an equal volume. Prof. Poynting follows the older supposition that each molecule of dissolved matter combines with the solvent to form unstable compounds but with the addition that these continually exchange constituents. The molecules of solvent thus combined will be less energetic than the molecules of pure solvent, and thus may be unable to evaporate. Nevertheless, since they are always being liberated and recombined, they will still be effective in retaining molecules of vapour condensing on the surface. The vapour pressure will therefore be reduced, and it follows that if we make the additional assumption that one molecule of the dissolved substance unites with one molecule of the solvent the fractional diminution of vapour pressure will be the same as that calculated from the osmotic pressure given by Van 't Hoff's law. We can, of course, working backward from this result, show that the osmotic pressure will have the gaseous value. If one dissolved molecule combines with two or three solvent molecules the osmotic pressure would have double or treble its normal value. Mr. W. C. D. Whetham, discussing this view, in a letter to *Nature* says: "The evidence in favour of the view that the opposite ions of an electrolyte are dissociated from each other is enormously strong, though there is no reason to suppose that the ions are not united to the solvent. Some of the chief points in favour of their freedom may shortly be summarised as follows: (1) The fact that the electrical conductivity of a dilute solution is proportional to its concentration; whereas, if the ions moved forward by taking advantage of collisions between the dissolved molecules and consequent rearrangements, it would vary as some power of the concentration higher than the first. (2) The confirmation of the values given by Kohlrausch as the specific velocities of the ions, the velocity of each ion being, in dilute solution, independent of the nature of the other ion present. (3) The successful calculation by Nernst and Planck of the coefficients of diffusion of electrolytes, and of the contact differences of potential between their solutions on the hypothesis that the ions migrate independently of each other. Thus we cannot lightly give up the idea that the ions are free from each other, and it seems to me that a very simple extension of Prof. Poynting's theory will enable us to retain that view. We have only to suppose that, in the case of electrolytes, the dissolved molecules are resolved into their ions, and that each ion so produced unites with one solvent molecule, or, at all events, destroys the mobility of one solvent molecule. A simple compound like NaCl, which is decomposed into two ions, Na (positive) and Cl (negative), will thus produce double the normal effect on the osmotic pressure and its consequences, the diminution of vapour pressure and the lowering of the freezing point. In the same way a molecule like H_2SO_4, which gives three ions, will produce three times the effect which would be obtained if it were undissociated." As to all this it has always seemed to us that, although the laws on which it is founded are beyond doubt, the current theory of ionic dissociation has been accepted because it is a complete explanation of them, which works out mathematically correct, and without considering whether it is the only possible explanation. It is not always the simplest suggestion that is the true one, and the recent light that has been thrown on the manner in which conduction takes place through gases would seem distinctly to favour some theory like Prof. Poynting's in the case of fluids.

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THE PRINCIPLES OF ALTERNATE-CURRENT WORKING.*

BY ALFRED HAY, B.SC.(EDIN.), A.I.E.E.

(Continued from page 483.)

95. If the periodicity is so related to the inductance and capacity that the condition $L p = \frac{1}{C p}$ is fulfilled, then it follows, by the last article, that the current will be in phase with the impressed E.M.F. This phenomenon of the neutralisation of an inductance by means of a capacity is generally referred to as *electrical resonance.* As an example, let us suppose that it is required to neutralise an inductance of ·0127 henry, when the periodicity is 100 ~ per second. Let C stand for the capacity required. Then we have

$$L p = ·0127 \times 2 \pi \times 100 = 79·5.$$

Hence we must have $C p = \frac{1}{L p} = ·01258$,

so that $C = \frac{·01258}{200 \pi} = \frac{·01258}{628·32} = 2 \times 10^{-5}$ farads approximately, or C = 20 microfarads.

Let us suppose, further, that the resistance of the circuit is 10 ohms, and that the impressed E.M.F. is 100 volts. The current is in this case $\frac{100}{10} = 10$ amperes. The P.D. at the condenser terminals is $\frac{10}{C p} = 79·5 \times 10 = 795$ volts, or almost *eight times as great as the impressed E.M.F.* The P.D. across the inductive resistance is $10 \sqrt{r^2 + p^2 L^2} = 10 \times 80·1 = 801$ volts.

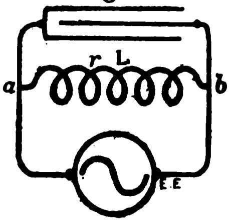

FIG. 67.

We therefore see that a comparatively small impressed E.M.F. may under suitable conditions give rise to very high P.D.'s between certain points in the circuit. It is important to bear this fact in mind, for neglect of the necessary precautions might in some cases result in the breaking down of costly apparatus which was never intended to stand the P.D. to which it was unwittingly subjected.

Excessive rises of P.D. in a circuit may be prevented by the introduction of sufficiently large non-inductive resistances. Thus, if in the example just considered we suppose that the resistance of the circuit is 50 ohms instead of 10, the current will be two amperes, and the P.D. at the condenser terminals only 79·5 × 2 = 159 volts instead of 795 as in the first case.

If a rise of P.D. is not objectionable, then we may take advantage of the phenomenon of electrical resonance to increase the current in an inductive circuit when the available impressed E.M.F. is insufficient for the purpose.

96. We shall next consider the effect of shunting an inductive resistance by means of a condenser. If the student has followed the explanation given above for the case of a condenser placed in series with an inductive resistance, he will have no difficulty in understanding what follows.

Let r and L denote the resistance and inductance of the circuit, and C the capacity of the shunting condenser. The arrangement of connections is shown in Fig. 67. Let E stand for the amplitude of the simple harmonic P.D. which is maintained between the points a and b. The problem is to find the currents in the various branches of the circuit.

* Based on a series of evening lectures delivered at the University College, Liverpool.

The amplitude I_1 of the current in the inductive part of the circuit is, by Art. 38, equation (23), equal to $\frac{E}{\sqrt{r^2 + p^2 L^2}}$. Proceeding as in Art. 92, we lay off a vector O L (Fig. 68), of length I_1; a vector O M, of length r I, and at right angles to this a vector O N, of length $L p$ I. The resultant of O M and O N is O P, whose length is E. Let this diagram of vectors revolve round O with constant angular velocity p. Then the projections of the vectors O L, O M, O N, and O P on the vertical axis at any instant give the instantaneous values of the current in the inductive part of the circuit, the $r i$ component of the impressed P.D., the $L i'$ component, and the total impressed P.D. respectively. Since the capacity of the shunting condenser is C, the amplitude of the condenser current I_c is, by Art. 92, equation (25), equal to p C E, and we know that this current is $\frac{\pi}{2}$ in advance of the impressed P.D. as regards phase. Hence, if we draw a vector O R, of length I_c, at right angles to O P, the projection of this vector on the vertical axis at any instant will give the value of the condenser current. Now, the total current which comes from the source of alternating E.M.F. is at every instant equal to the algebraical sum of the currents through the inductive part of the circuit and through the condenser. Hence the total current at any instant is equal to the sum of

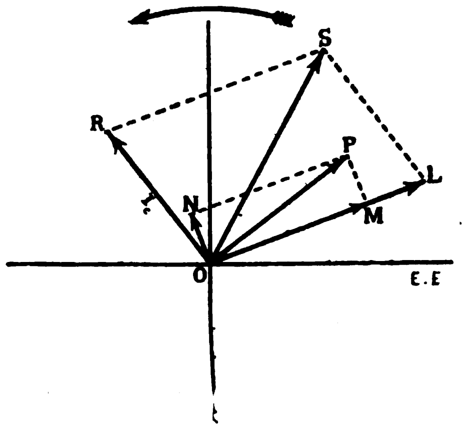

FIG. 68.

the projections of O L and O R on the vertical axis, or, which comes to the same thing, the projection of O S on the vertical axis; O S being the resultant of O L and O R.

97. From the diagram, Fig. 68, it is evident that the current in the main circuit may be either greater or less than the current through the inductive resistance. Let us suppose that the resistance and inductance of the circuit are fixed, but that we have the means of varying the capacity of the shunting condenser. The amplitude of the impressed P.D. is also supposed to be fixed. This is equivalent to saying that the vectors O L, O M, O N, and O P are all given, but that the length of the vector O R may be varied (the direction of O R is fixed, since it must always be at right angles to O P). The length of the vector O R will evidently be in direct proportion to the capacity of the shunting condenser, since $I_c = p$ C E. When the capacity is nothing—*i.e.*, when the condenser is entirely removed—the vector O S will be coincident with O L, which is another way of expressing the fact that the current in the main circuit is the same as that in the inductive resistance. As the capacity is gradually increased, the extremity S of the vector O S will travel along the straight line L S, which is parallel to O R. The current in the main circuit will therefore gradually diminish and *reach a minimum value* when O S becomes perpendicular to L S (or coincident *in direction* with O P)—*i.e.*, when the *current in the main circuit comes into phase with the impressed E.M.F.* If the capacity is still further increased, the vector O S will increase in length and at a certain stage become equal to O L; it will then go on increasing indefinitely as the capacity is increased. Now, it is evident from the diagram that for all values of the current in the main circuit which lie between the *minimum* value of that current and its value when the shunting capacity is zero, we may have *two* different values

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of the capacity. With the *smaller* value of the capacity, the current will *lag*, the vector O S lying between O L and O P; with the *larger* value, the current will *lead* by the same amount, the vector O S lying on the other side of O P.

We shall work out a numerical example to illustrate this point. Let $r = 6$ ohms, $L = \cdot01273$ henry, $E = 100$ volts, and let the periodicity be 100 ~ per sec. The impedance is $\sqrt{r^2 + p^2 L^2} = 10$, hence $I_1 = \frac{100}{10} = 10$. If θ denote the angle of lag between the impressed P.D. and the current in the inductive resistance, then, by Art. 38, equation (24), $\tan\theta = \frac{Lp}{r} = \frac{8}{6} = \frac{4}{3}$. Take a line O L (Fig. 69), of total length 10, and at L draw L A at right angles to O L, making $LA = \frac{4}{3} OL$. Then $\tan LOA = \frac{LA}{OL} = \frac{4}{3} = \tan\theta$. Hence the angle L O A is equal to the angle of lag θ. From L draw L T at right angles to O A. The lines O L and L T in Fig. 69 correspond to O L

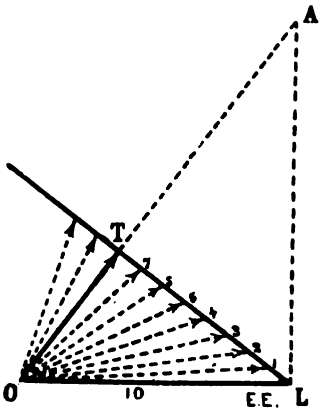

Fig. 69

and L S in Fig. 68. When there is no shunting condenser, the maximum value of the current in the main circuit is the same as in the inductive resistance—viz., 10—and the angle of lag is L O A.

Let us now introduce a shunting condenser and gradually increase its capacity. Suppose we consider values of the capacity corresponding to 1, 2, 3, etc., amperes of maximum condenser current. Since $I_c = pCE$, we get $C = \frac{I_c}{pE} = \frac{I_c}{200\pi \times 100}$; corresponding, therefore, to 1 ampere of the maximum condenser current we have a capacity of 15·92 microfarads, corresponding to 2 amperes, $2 \times 15{\cdot}92$

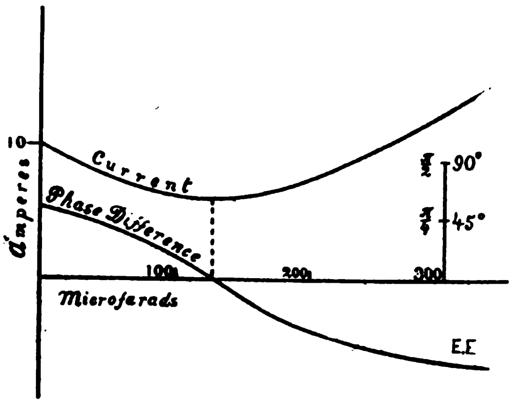

Fig. 70.

or 31·84 microfarads, etc. In order to determine the effect of this condenser current on the current in the main circuit, we lay off lengths L 1, L 2, L 3, etc., and join the point O to the points 1, 2, 3, etc. The lines O 1, O 2, O 3, etc., give the values of the maximum current I in the main circuit, and the angles 1 O T, 2 O T, 3 O T, etc., the corresponding values of the angle of lag between the impressed E.M.F. and the current in the main circuit. Taking corresponding values of the capacity and the maximum current in the main circuit, we may plot a curve as in Fig. 70, showing the relation between these two quantities. Another curve, shown in the same figure, may be plotted to exhibit the connection between the capacity of the shunting condenser and the phase difference between the impressed E.M.F. and the current in the main circuit. The angle of phase difference is reckoned *positive* if the current *lags*, *negative* if it *leads*.

(To be continued.)

RAILWAY BLOCK SIGNALLING.

BY J. PIGG.

(Continued from page 486.)

The bell code in use does not differ materially from that in use for double-line working in cases where all distinguishing signals are by bell, and need not be further referred to.

The operation of withdrawing a staff at either cabin is very simple, and can only be done by the joint action of the two signalmen at opposite ends of the section. (The connections being identical at each end only one station is shown in the diagram.) Assuming that a staff is to be withdrawn at "A" under the conditions of the apparatus as shown by Fig. 88, and that the preliminary notification signals have been given and accepted, the operation is as follows: "A" places the right-hand switch to "for staff," "B" depresses bell key and keeps it down, "A" withdraws staff, and then turns the left-hand switch to "up staff out," turning the switch *hard down* before releasing

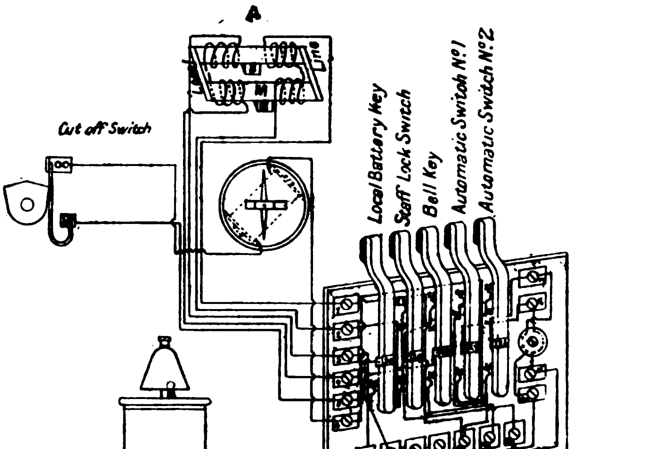

Fig. 88.—Webb and Thompson's Electrical Train Staff Diagram of Connections for One Section of Single Line.

it. This latter action notifies "B" that the staff is out, and he releases the bell key. This completes the operation, the right-hand switch at "A" being replaced automatically to "for bell" during the operation of withdrawing the staff.

Remembering that the "local battery" bar is making contact at "31," and the "staff lock" bar at "32," at "A," and that the "bell key" at "B" is making contact at "33," it will be seen that two currents are passing around the staff lock electromagnet, M, at "A"; and following the directions of the currents through the windings of the "local" and "line" coils respectively, it will be found that the resultant magnetic effect is to produce poles at "N" and "S" (Fig. 88). Under these circumstances the lock, L, will be raised, with the electromagnet, M, by the movement of the lever, *l*, when the staff is being withdrawn from the pillar towards H (Figs. 86 and 87). The paths of these

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currents, in the positions occupied by the automatic switches Nos. 1 and 2, at "A" and "B," is as follows:

"A."	"B."
	From carbon of line battery to 12, 33, 28, 5, cut-off switch and galvanometer, 6, 18, 25, 26, 17, 14, 9, and line wire to
9, 14, 17, 26, 25, 18, 6, cut-off switch and galvanometer, 5, 28, 23, 20, 29, 32, 2, line coils, 1, 11, 19, 24, 27, 16, 15, 10 to earth, and	10, 15, 16, 27, 24, 19, 11 to zinc of line battery.
Local battery. From carbon to 8, 31, 30, 4, local coils, 3, 7, to zinc.	

These currents excite the electromagnet, M, and it will be noted that not only are two currents necessary, but their directions must be in accordance in order to do this. Since the electromagnet is provided with a complete magnetic circuit, either of the two currents would fail to excite it, effectively, for the purpose it is intended for alone; and if the direction of either current is reversed, the effect upon the lock pawl, L, will be nil. The method of obviating the disadvantages of an air-gap by making the lock pawl, L, the armature for the consequent poles developed is also worthy of notice.

The movement of the cam-wheel changes the points of contact of the switch bars Nos. 1 and 2 from "24" and "25" to "34" and "35." The breaking of the contacts of these bars with "24" and "25" breaks the path of the current from "B," and releases L from M; this path being immediately replaced by another through "34" and "35." If the new path is traced it will be found that the current from B has been reversed in direction through the line coils at "A," and consequently poles are not formed at "N" and "S" as before, and the lock pawl will be unaffected by any subsequent movement of M whilst these conditions obtain. Not only is this the case, but if the operations described are gone through with the object of liberating a staff at "B" it will be found that the direction of the currents through the line coils at "B" is such, as, in conjunction with the fixed direction of the current through the local coils, is ineffective for the purpose of raising L in order to allow the cam-wheel to turn.

The instruments are said to be "out of phase" when the switch bars Nos. 1 and 2 make different contacts at the two ends of the section, and they can only be made operative again by putting them "in phase." This may be done by replacing the staff in either A's or B's pillar. In the first case the switch bars Nos. 1 and 2 at "A" return to the top contacts "24" and "25"; in the second case the switch bars at "B" are caused to make contact with the bottom springs "34" and "35," and thus make contacts at the same points as the similar bars do at "A." Shortly, if the paths of the currents are traced, under the various conditions necessary, it will be found that staffs may be withdrawn at either place when the switch bars Nos. 1 and 2 make similar contacts only.

It will be noticed from the path of the line current that it passes through the galvanometer at each cabin, and, therefore, during the time the bell key at "B" is depressed, to enable a staff to be withdrawn at "A," the galvanometer needles are deflected. Some means of notifying "B" of the completion of the operation of withdrawal is necessary, and this is effected by breaking the circuit at the cut-off switch by pressing it hard over, as already observed. Both galvanometer needles assume a vertical position, and the signalman at "B" accepts this as an indication of the completion of the operation.

The right-hand switch is automatically replaced to "for bell" by the turning of the cam-wheel, and a study of the connections will show that at the moment of replacement the current will pass through the bell at "A." No notice of the one blow on the bell, resulting from the change of connection, is taken, and it is of no significance whatever, since the man engaged in withdrawing the staff requires no signal to tell him when he has got it out.

Such an instrument as that just described is obviously a great advance on the simple single staff and ticket system, in so far as facilitating the working of traffic and immunity from danger of accident is concerned. Under ordinary circumstances there need be no delay, as in the single-staff system, owing to the staff being away; and the lock, L, being contained in a strong lock-up iron case, if the batteries and connecting wires are protected against being tampered with it is not possible to, even burglariously, take a second staff out of either pillar. This, of course, is the premier object of the design, without which it would be worthless as an instrument for single lines. A minor point in connection with the design of the instrument may be noticed. It is that, although both men are actively engaged during the whole time occupied in withdrawing a staff at either end of the section, only one

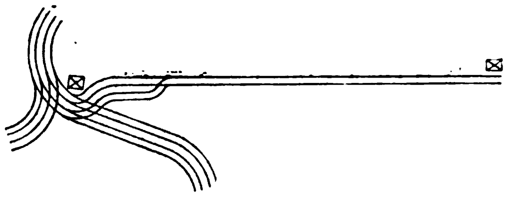

Fig. 89.

of them is concerned with its replacement. Under these circumstances it will be observed that it is not *essential* for the signalman at the sending end of the staff section to remain in his cabin until the last train through the section at night, say, has been signalled out. The staff can be placed in the pillar at the opposite end, and the two instruments put in "phase," without the assistance of the man at the point from which the train started. An understanding between the signalmen would, of course, have to exist before this could be done.

Single lines differ considerably in character. Some, as Fig. 89, end as single lines; others, again, form a connecting link between two double lines, as Fig. 90, and feed both. With such a line as Fig. 89 the traffic is bound to balance—*i.e.*, the same number of trains must emerge at the junction as enter it—and the number of staffs kept at each staff cabin will remain fairly constant. In such a case as is shown by Fig. 90] this may not occur, especially where the single line is fed from a number of points in its length, and there exists a number of staff stations between the extreme points of the single line. A number of trains may enter at one junction and leave by the other, and there would thus be an accumulation of staffs at some

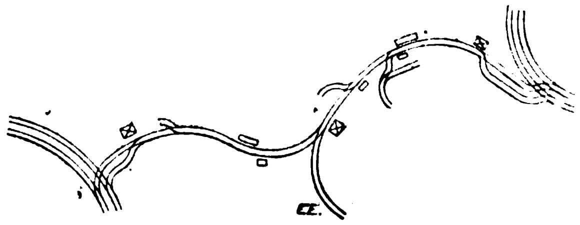

Fig. 90.

point and a corresponding denudation at another point, dependent upon the preponderating direction of traffic. In such cases, for instruments such as Webb and Thompson's, and others of similar design, special means have to be taken to restore the balance of staffs, or the line would ultimately be in the same condition as with a single-staff system. This is usually done by giving to the telegraph lineman for the district a key which will open the case of the instrument and enable him to lift the lock, L, by hand until a sufficient number of staffs has been removed from the pillar having a surplus for conveyance to the point where a deficiency exists. Of course, this is only done under the supervision of the more responsible officials of the locality; and the person removing staffs in this way must give and take receipts for them, and it must only be done at such time as no staff is in ordinary use. In this connection it will be noticed that an *even* number of staffs must be removed for conveyance to the opposite end of the section, in order that the instruments may be left in "phase" for ordinary work during the time occupied in

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conveying the staffs from one point to the other. If the lineman conveys his bundle of staffs by a train passing in that direction, the driver must be furnished with a separate one, in order to leave the instruments out of "phase" during the passage of the train through the section.

On single lines where the traffic is light at night provision is made for switching out an intermediate staff station, staff working being carried on between the two cabins on each side. In such cases the instruments for working the longer section are distinct from those working to the intermediate station, and the staffs are of such form and size as to prevent them from being worked in conjunction with any instrument but the right one. The switching operation is somewhat elaborate, and a good idea will be more readily formed from the instructions given for its performance.

"As soon as the train next before the time specified in the working time-table for switching out has passed B and has arrived at C or A, as the case may be, and train out of section......... has been received for it at B, the signalman at B must ascertain by single needle or telephone, as the case may be, that all the staves at A and C are in their respective staff pillars. Having ascertained that such is the case he must give ('closing cabin signal') on bell........., which signal must be acknowledged. B must then peg down the bell key of each of his staff instruments by means of the pin provided for the purpose, and A and C must each of them hold down the bell key of the instrument working to B, which will be shown at B by the deflection of the needles. This action electrically unlocks the switch at B and permits that station to switch out, which he must do by depressing the lever on his switch instrument and turning the pointer from 'Switched in' to 'Switched out.' Having done this, he must send to A and C on the single needle, A A A.........which signal must be repeated to show that it has been understood, which will call the attention of these stations to the fact that the action of closing B has been accomplished (or where single needles do not exist the communication must be made on the telephone). On the receipt of this signal on the single needle, or the notification by telephone, A and C may cease to hold down their keys. All the instruments at the three stations have thus become disconnected, and the staves, both local and through, locked up in them. In order to bring the through staff instruments into operation, A and C must then turn the pointer of their battery switches from intermediate station to through section, which act will connect the through instrument at A with the through instrument at C. Stations A and C must then exchange the test signal with each other, and having done so must intimate to B that their through instruments are in circuit by sending him, by the single needle or telephone, the word 'through.' B is thus made aware that A and C are working on the through circuit, and after switching out his cabin-to-cabin single needle or telephone in the usual manner, if he is supplied with one, and unpegging the bell key on each of his staff instruments, he may close his cabin and leave."

"The rules for opening B are as follows: On the arrival of the signalman at B he must first switch in the cabin-to-cabin single-needle instruments if they exist (but if the telephone is in use without a single needle then a verbal communication must be made on that circuit), and then send 15 beats on the needle, thus (five to the left, five to the right, and five to the left) to A and C. If there is no staff out of the pillars, A and C must each return the code of 15 beats, and then hold down their bell keys on the through staff instruments, which will unlock the switch at B. B must then depress the lever of his switch instrument and turn the pointer from switched out to switched in, and having done so he must move the handle of the single-needle cabin-to-cabin instrument to and fro three times—thus, N, N, N—which will call the attention of those stations to the fact that the action of opening B has been accomplished, and those stations must turn the pointer of their battery switches to intermediate station A and C must then each of them exchange with B the test signal on the bell, and working by local staff can then be commenced."

(To be continued.)

INSTITUTION OF ELECTRICAL ENGINEERS, Nov. 12.

THE TELEPHONE TRUNK LINE SYSTEM IN GREAT BRITAIN.

BY J. GAVEY, MEMBER.

In the early days of the telephone, whilst various local systems were being developed, and before the idea of providing trunk lines between neighbouring towns had been matured, the question of long-distance telephony received careful consideration. The pioneer experimenters at once found themselves face to face with the numerous troubles, generally ascribed to induction, which rendered speech impossible on single-wire circuits during the busy telegraphic hours of the day, and very difficult on such metallic loops as could be made up from existing telegraph circuits. In a paper read before the Physical Society on January 19, 1878, Mr. Preece described the various causes to which these disturbances were due, and he suggested a method of screening a single-wire circuit both from electrostatic and electromagnetic induction. He also pointed out the true solution of the difficulty—*i.e.*, the use of metallic circuits for telephonic purposes—a practice adopted by the Post Office from the first, and one that has been consistently urged as necessary if a really efficient telephonic service is sought. Prof. Hughes continued the subject in his paper read before the Institution on March 12, 1879, in which he described the method of revolving the two wires of a metallic loop to obtain a practical balance. In a subsequent paper read before the British Association in 1885, Mr. Preece pointed out the merits of copper as a conductor, and in 1887 he enunciated the K R law in a paper read before the Royal Society.

The following are the theoretical principles involved in the erection of balanced telephone circuits: when two complete circuits, either wholly metallic or partly metallic and partly earth, are placed in juxtaposition, each is subject to the following interferences on the establishment, the cessation, or the variation in the volume of a current of electricity in the other:

1. *Induced Currents due to Electromagnetic Induction.*—If two circuits or portions of circuits be contiguous to one another, then, on establishing a current in No. 1 circuit (Fig. 1), a

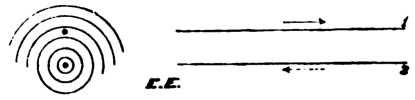

Fig. 1.

certain number of magnetic lines of force cut No. 2, and a current of brief duration is observed in the lattter, and, disregarding direction for the present, corresponding results are observed on the increase, the cessation, or the diminution of the current in No. 1.

2. *Induced Currents due to Electrostatic Induction.*—Electrostatic induction induces a momentary redistribution of electrification in neighbouring wires, the result being the passage either transversely or longitudinally of currents of short duration. The cessation of the primary current results in momentary induced currents in the reverse direction to the former.

3. If a single wire with an earth return be used, in addition to the above results, leakage from the earth-plates and stray currents from other electrical circuits, or from the earth itself, enter the circuit. This aspect of the case may, however, be disregarded at present, for in practice trunk circuits always consist of metallic loops.

If we consider the combined effects of electromagnetic and electrostatic induction from a single-wire circuit with an earth return—first, on a similar circuit, and then on a looped or balanced circuit—we get the results, on the closing or the increase of the current in the primary circuit, which are

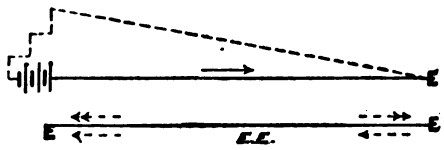

Fig. 2.

illustrated in Fig. 2, where the continuous arrow, ——>, shows the primary current, the dotted arrows, — — —>, the induced current due to electromagnetic induction, and the double-barbed arrows, — — —>>, that due to electrostatic induction.

The reverse results are observed on the breaking or diminution of the current in the primary circuit. It will be observed that in unbalanced earthed circuits the current due to electromagnetic induction is opposite to that in the primary on closing the latter, whilst that due to electrostatic induction is in the

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same direction as the electromagnetic induction current at the battery end, and in the opposite direction at the far end. Thus, at one end of such a circuit a disturbance due to the sum of the two currents is observed, whilst at the other end one due to the difference alone is seen.

In the case of the balanced circuit, if all the conditions for silence indicated below are realised, the result of electromagnetic induction is that similar potentials are developed along both sides of the loop; the single-barbed dotted arrows

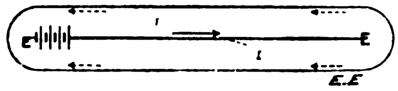

Fig. 3.

(Fig. 3) showing the direction only that the current would flow in either branch if, owing to defective balance, the potential in the other were reduced.

The electrostatic effect will depend on the condition of the circuit. If the primary or disturbing circuit be perfectly insulated, and if it be disconnected at the far end, or if it be terminated in a condenser, and if the insulation of the secondary be extremely high, minute currents cross the conductor transversely so as to effect the redistribution illustrated by + and − signs in Fig. 4, no currents in a longitudinal direction being

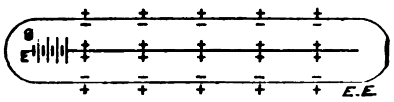

Fig. 4.

developed. If, however, the disturbing or primary circuit be to earth, or if it consist of a neighbouring loop, minute longitudinal currents in the direction shown by the double-barbed arrows in Fig. 5 actually circulate. The combined effects on a balanced loop with the resultant earth in the centre of each wire are illustrated in Fig. 5A.

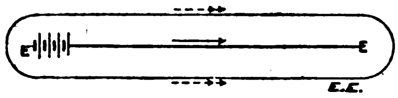

Fig. 5.

With open wires, however, leakage always takes place over the insulators; hence a much larger static charge is accumulated than with a perfectly insulated secondary, the above conditions are subject to variation, and an actual flow of current in each arm takes place, the direction of which is dependent on the distribution of the leakage, or the position of the resultant earths.

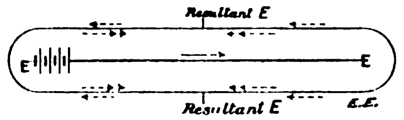

Fig. 5A.

The conditions which are necessary to obviate interference due to the above causes between two neighbouring circuits, one of them at least being a metallic loop, are the following. For practical purposes each circuit which has great length compared to its depth is considered to consist of two sides alone, the ends being neglible. (1) Each of the wires of one loop should maintain throughout the same or an average equal distance from each of the wires of all neighbouring loops; (2) the two conductors of each loop should be of the same material; (3) they should have the same conductivity; (4) each half of the circuit, including apparatus in direct circuit, should possess the same coefficient of self-induction; (5) they should have similar electrostatic capacities; (6) they should have the same degree of insulation, whether high or low; (7) the resultant faults due to loss of insulation should be in the centre of each wire of the loop, but if not there, each should occupy similar positions at equal distances electrically from the extremities.

The necessity for the above conditions is obvious when it is considered that the induction from all neighbouring wires causes constant variations of potential and local currents to circulate along each wire, which must not affect the telephones at either end. Thus, any difference in electromagnetic inertia, resistance, or capacity between the two arms of a circuit will cause currents to traverse the terminal telephones. With a symmetrical circuit these two telephones occupy absolutely neutral positions at opposite extremities of the circuit, and if each telephone be wound differentially and be perfectly balanced earth may be applied at the centre of each instrument without creating disturbance, whereas, if earth be applied at any other point in the circuit, even at the point where the line wire joins the telephone, the disturbance from neighbouring wires becomes at once marked. Again, any two points of equal potential in the circuit can be bridged without creating disturbance, which means that any number of telephones or indicators may be placed in multiple arc across the balanced wires without upsetting the balance.

Conditions 1 to 5 are readily met, and once attained they are stable. No. 6 is more difficult to ensure, for the insulation of either arm of a loop may at any time be lowered by innumerable accidental causes, so that the most careful attention to maintenance is necessary to remove this source of trouble. No. 7 is at times a source of considerable difficulty, especially in the case of telephone trunks erected on poles carrying high-speed Wheatstone wires when the latter are worked with shunted condensers. Thus, in Fig. 6, with the resultant earths at points 1, points 2, or at other symmetrical positions, the circuit is silent; but with positions 3 disturbance becomes evident, for the currents entering at these points traverse the telephones in establishing the electrostatic redistribution.

Normally, the currents due to electromagnetic induction would be more considerable than those arising from electrostatic

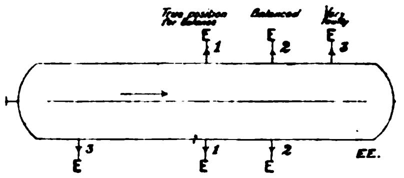

Fig. 6.

induction in a single-wire circuit with an earth return. Experiments made between Newport, Cardiff, Swansea, and Haverfordwest between ordinary parallel wires under certain conditions gave the ratio between the two as 9,096 : 306 at the battery end and 9,096 : 153 at the far end; and the disproportion would be still more marked in a loop. Notwithstanding these facts, it is far easier with open wires to balance magnetic than static disturbance, as the conditions necessary to ensure the former are more readily controlled. This is illustrated by a simple experiment with a high-speed transmitter working an ordinary telegraphic circuit, attached to the same poles as a balanced loop. With the telegraphic circuit to earth, in the usual manner at the far end, and a current of 30 or 40 milliamperes, the balanced loop may be practically silent. Add a shunted condenser, or disconnect the far end of the telegraph circuit, and disturbance may become most marked. The effect is much greater than would be accounted for by the mere fact that in the extreme case of the far end being disconnected the average

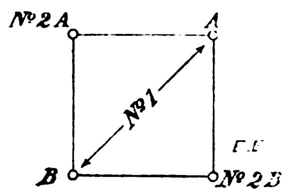

Fig. 7.

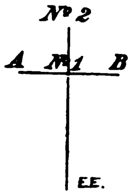

Fig. 8.

potential of the disturbing line is as a maximum doubled throughout. The fact is that when the primary circuit is disconnected, or a shunted condenser is fitted at the extremity, the rise and fall of potential is practically instantaneous, and the effect on the telephone circuit is at its maximum; whereas with the conditions for simple working the electromagnets of the receiving instrument cause a flattening of the current curve and the rise and fall of potential is too slow to injuriously affect the telephone.

The methods of construction of telephone trunk lines differ but slightly from those adopted in the erection of ordinary telegraph lines, the principal difference arising from the necessity for providing the balanced circuits referred to above.

Taking first the simple case of two contiguous metallic circuits, if they be arranged so that the two arms of each loop are at diagonally opposite angles of a square (Fig. 7), then the condition No. 1 is observed, and the circuits are balanced for distance whether the wires are run straight or whether they revolve; and in a similar manner a loop on a horizontal arm (Fig. 8) is balanced against a single wire on a saddle with an earth return, so long as the single wire is at the apex of an isoceles triangle of which the loop forms the base. With this exception, to obtain a balance between one loop and a second circuit external to it, whether metallic or with earth return, the wires of each loop must revolve uniformly the one round the other. In underground work this revolution is a uniform spiral, but with open work the wires simply change their positions regularly on each successive pole. In England the

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method adopted is almost uniform, and it consists in continuous changes of position, every wire being moved transversely at an angle of 90deg. at each pole, so that a complete revolution is effected in every four spans. Other methods of crossing have been adopted on the Continent, but the above is perhaps the most simple way of achieving the end in view. In some cases the wires are run parallel and crosses introduced at intervals to obtain an approximate balance.

The present practice is to erect four wires on arms 48in. long, divided as shown in Fig. 9, the arms being fixed on the poles 12in. apart from centre to centre. Thus, two arms provide space for four metallic circuits, the four wires on each side of the pole forming a section of a 12in. square, the diagonal wires in these squares being taken up by each circuit.

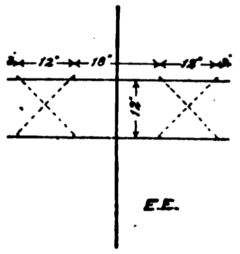

Fig. 9.

Of course, as previously pointed out, the two diagonal circuits in one square are perfectly balanced against one another, and therefore free from mutual disturbance, but in dealing with a large number of telephone loops, if the relative average distance between each of the two wires of any one circuit, say, in the right-hand square and those of the two wires forming each circuit in the left-hand square be measured, it will be found, when all wires have the same twist, either right or left handed, that the average distances between wires of the circuits, the diagonals of which are at right angles to one another, are equal, whilst those that are parallel are not. If one square has a right-hand and the other a left-hand twist, then the converse is true—viz., the circuits that are parallel at each pole are balanced, and those that are transverse are not. It is found in practice that disturbances that arise between neighbouring twisted circuits can be eliminated by crossing systematically. Thus, dealing with a number of circuits on one route, the four wires forming the first square may be revolved uniformly throughout. The next four have the A and B wires of each circuit crossed eight miles from the starting point, and at intervals of eight miles onwards. The third group have the first cross four miles from the former point, then the remainder of the crosses succeed at intervals of eight miles. The wires of Group 4 are crossed throughout at intervals of four miles. Those of Group 5 have the first cross two miles from the terminal, then the remainder of the crosses at four-mile intervals. Group 6 is crossed at intervals of two miles. It will be observed, on examination of Fig. 10, which illustrates the arrangement, that each circuit is balanced against all the neighbouring ones, and by this simple method it has been found possible to establish a series of wires absolutely free from overhearing.

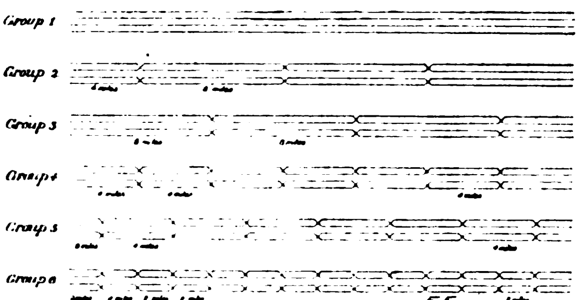

Fig. 10.

Hard-drawn copper wire is universally used for trunk lines. Its high conductivity, its freedom from electromagnetic inertia, its great strength, and its durability, fit it eminently for this class of work. The trunk lines erected by the Post Office vary in gauge from wires weighing 100lb. per mile to wires weighing as much as 800lb. per mile. The use of such heavy wire as the latter was a subject of much controversy when the present policy of the Department was decided upon, but the results obtained have fully justified the action taken by Mr. Preece. There is, of course, no doubt that with overhead wires pure and simple it would have been quite possible to speak from one end of Great Britain to the other with smaller wires than those actually used for the "backbone system," but many critics appear to have overlooked the fact that this system was designed with a view to provide for conversation through submarine cables and through city underground work between London, Belfast, Dublin, and the Continent on the one hand, and the great provincial business centres on the other.

The resistances and the inductive capacity of the various overground wires used in practice are as follows:

Lbs. per mile.	Resistance, standard ohms.	Capacity to E.	Capacity, wire to wire.
100	8·782	0·0144	0·00864
150	5·854	0·0147	0·00882
200	4·391	0·0150	0·00900
300	2·929	0·0153	0·00918
400	2·195	0·0156	0·00936
600	1·464	0·0158	0·00948
800	1·098	0·0160	0·00960

It will be observed that with the standard distances at which the wires of a loop are erected in this country the capacity, wire to wire, is 0·6 that of the wire to earth.

The use of underground wires for trunk lines was utterly impracticable so long as guttapercha, indiarubber, and other kindred materials only were available for insulating purposes. The introduction of what is practically an air-space cable by the use of paper insulation appears to offer the solution of a difficulty looming in the immediate future—namely, the finding of space for the numerous wires, both telegraphic and telephonic, which will be required between busy centres. Unfortunately, the need for two wires for each telephone circuit results in the rapid filling up of all aerial supports; and the undesirability of overcrowding poles with wires in a climate like ours, subject to snowstorm interruptions, is obvious.

(*To be continued.*)

MOTORCAR REGULATIONS.

The Local Government Board have, in accordance with the power given by the Locomotives on Highways Act of 1896, issued the following regulations. The regulations have been forwarded to all the county councils, sanitary authorities, urban district councils, and rural district councils throughout the United Kingdom. The document will be called "The Light Locomotives on Highways Order, 1896," and is dated November 9.

Article I.—In this order—The expression "carriage" includes a wagon, cart, or other vehicle. The expression "horse" includes a mule or other beast of draught or burden, and the expression "cattle" includes sheep. The expression "light locomotive" means a vehicle propelled by mechanical power which is under three tons in weight unladen, and is not used for the purpose of drawing more than one vehicle (such vehicle with its locomotive not exceeding in weight unladen four tons), and is so constructed that no smoke or visible vapour is emitted therefrom except from any temporary or accidental cause.

In calculating for the purposes of this order the weight of a vehicle unladen, the weight of any water, fuel, or accumulators used for the purpose of propulsion shall not be included.

Article II.—No person shall cause or permit a light locomotive to be used on any highway, or shall drive or have charge of a light locomotive when so used, unless the conditions hereinafter set forth shall be satisfied—namely:

1. The light locomotive, if it exceeds in weight unladen 5cwt., shall be capable of being so worked that it may travel either forwards or backwards.

2. The light locomotive shall not exceed 6½ft. in width, such width to be measured between its extreme projecting points.

3. The tyre of each wheel of the light locomotive shall be smooth and shall, where the same touches the ground, be flat and of the width following—namely: (*a*) if the weight of the light locomotive unladen exceeds 15cwt., but does not exceed one ton, not less than 2½in.; (*b*) if such weigh exceeds one ton, but does not exceed two tons, not less than 3in.; (*c*) if such weight exceeds two tons, not less than 4in.

Provided that where a pneumatic tyre, or other tyre of a soft and elastic material is used, the tyre may be round or curved, and there may be upon the same projections or bosses rising above the surface of the tyre if such projections or bosses are of the same material as that of the tyre itself, or of some other soft and elastic material. The width of the tyre shall, for the purpose of this proviso, mean the extreme width of the soft and elastic material on the rim of the wheel when not subject to pressure.

4. The light locomotive shall have two independent brakes in good working order, and of such efficiency that the application of either to such locomotive shall cause two of its wheels on the same axle to be so held that the wheels shall be effectually prevented from revolving, or shall have the same effect in stopping the light locomotive as if such wheels were so held.

Provided that in the case of a bicycle this regulation shall apply as if, instead of two wheels on the same axle, one wheel was therein referred to.

5. The light locomotive shall be so constructed as to admit of its being at all times under such control as not to cause undue interference with passenger or other traffic on any highway.

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6. In the case of a light locomotive drawing or constructed to draw another vehicle, or constructed or used for the carriage of goods, the name of the owner, and the place of his abode or business, and in every such case, and in the case of every light locomotive weighing unladen one ton and a-half or upwards, the weight of the light locomotive unladen shall be painted in one or more straight lines upon some conspicuous part of the right or off-side of the light locomotive in large legible letters in white upon black or black upon white, not less than 1in. in height.

7. The light locomotive and all the fittings thereof shall be in such a condition as not to cause, or to be likely to cause, danger to any person on the light locomotive or on any highway.

8. There shall be in charge of the light locomotive when used on any highway a person competent to control and direct its use and movement.

9. The lamp to be carried attached to the light locomotive in pursuance of Section 2 of the Act shall be so constructed and placed as to exhibit during the period between one hour after sunset and one hour before sunrise, a white light visible within a reasonable distance in the direction towards which the light locomotive is proceeding or is intended to proceed, and to exhibit a red light so visible in the reverse direction. The lamp shall be placed on the extreme right or off-side of the light locomotive in such a position as to be free from all obstruction to the light.

Provided that this regulation shall not extend to any bicycle, tricycle, or other machine to which Section 85 of the Local Government Act, 1888, applies.

Article III.—No person shall cause or permit a light locomotive to be used on any highway for the purpose of drawing any vehicle, or shall drive or have charge of a light locomotive when used for such a purpose unless the conditions hereinafter set forth shall be satisfied—namely:

1. Regulations 2, 3, 5, and 7 of Article II. of this order shall apply as if the vehicle drawn by the light locomotive was therein referred to instead of the light locomotive itself, and Regulation 6 of the article shall apply as if such vehicle was a light locomotive constructed for the carriage of goods.

2. The vehicle drawn by the light locomotive, except where the light locomotive travels at a rate not exceeding four miles an hour, shall have a brake in good working order of such efficiency that its application to the vehicle shall cause two of the wheels of the vehicle on the same axle to be so held that the wheels shall be effectually prevented from revolving, or shall have the same effect in stopping the vehicle as if such wheels were so held.

3. The vehicle drawn by the light locomotive shall, when under the last preceding regulation a brake is required to be attached thereto, carry upon the vehicle a person competent to apply efficiently the brake. Provided that it shall not be necessary to comply with this regulation if the brakes upon the light locomotive by which the vehicle is drawn are so constructed and arranged that neither of such brakes can be used without bringing into action simultaneously the brake attached to the vehicle drawn, or if the brake of the vehicle drawn can be applied from the light locomotive independently of the brakes of the latter.

Article IV.—Every person driving or in charge of a light locomotive when used on any highway shall comply with the regulations hereinafter set forth—namely:

1. He shall not drive the light locomotive at any speed greater than is reasonable and proper having regard to the traffic on the highway, or so as to endanger the life or limb of any person, or to the common danger of passengers.

2. He shall not under any circumstances drive the light locomotive at a greater speed than 12 miles an hour. If the weight unladen of the light locomotive is 1½ tons and does not exceed two tons, he shall not drive the same at a greater speed than eight miles an hour, or if such weight exceeds two tons at a greater speed than five miles an hour.

Provided that whatever may be the weight of the light locomotive, if it is used on any highway to draw any vehicle, he shall not under any circumstances drive it at a greater speed than six miles an hour.

Provided also that this regulation shall only have effect during six months from the date of this order, and thereafter until we otherwise direct.

3. He shall not cause the light locomotive to travel backwards for a greater distance or time than may be requisite for purposes of safety.

4. He shall not negligently or wilfully cause any hurt or damage to any person, carriage, horse, or cattle, or to any goods conveyed in any carriage on any highway, or, when on the light locomotive, be in such a position that he cannot have control over the same, or quit the light locomotive without having taken due precautions against its being started in his absence, or allow the light locomotive or a vehicle drawn thereby to stand on such highway so as to cause any unnecessary obstruction thereof.

5. He shall when meeting any carriage, horse, or cattle keep the light locomotive on the left or near side of the road, and when passing any carriage, horse, or cattle proceeding in the same direction keep the light locomotive on the right or off side of the same.

6. He shall not negligently or wilfully prevent, hinder, or interrupt the free passage of any person, carriage, horse, or cattle on any highway, and shall keep the light locomotive and any vehicle drawn thereby on the left or near side of the road for the purpose of allowing such passage.

7. He shall whenever necessary, by sounding the bell or other instrument required by Section 3 of the Act, give audible and sufficient warning of the approach or position of the light locomotive.

8. He shall, on the request of any police-constable or of any person having charge of a restive horse, or on any such constable or person putting up his hand as a signal for that purpose, cause the light locomotive to stop and to remain stationary so long as may be reasonably necessary.

Article V.—If the light locomotive is one to which Regulation 6 of Article II. applies, and the particulars required by that regulation are not duly painted thereon, or if the light locomotive is one to which that regulation does not apply, the person driving or in charge thereof shall, on the request of any constable, or on the reasonable request of any other person, truly state his name and place of abode, and the name of the owner, and the place of his abode or business.

The following regulations as to the use of petroleum are also being issued conjointly with the above:

In promulgating the following regulations relating to the keeping, conveyance, and use of petroleum in connection with light locomotives, the Secretary of State for the Home Department desires to call public attention to the dangers that may arise from the careless use of those more volatile descriptions of petroleum to which these rules apply, being petroleum to which the Petroleum Act, 1871, applies, and commonly known as "mineral spirit." Not only is the vapour therefrom, which is given off at ordinary temperature, capable of being easily ignited, but also, when mixed with air, of forming an explosive mixture. Hence the necessity for strict precautions in dealing with and handling the same, and for the employment of thoroughly sound and properly closed vessels to contain the same, the importance of avoiding the use of naked lights in dangerous proximity to the same, or to any place where such petroleum may be kept, and generally of taking precautions to prevent contact of the highly-inflammable vapour of this very volatile liquid with any form of artificial light.

Regulations.

By virtue of the powers conferred on me by the fifth section of the Locomotives on Highways Act, 1896, I hereby make the following regulations for the keeping and use of petroleum for the purposes of light locomotives. Save as herein provided, the provisions of the Petroleum Acts shall apply to all petroleum kept or used or sold for the purposes of light locomotives.

In these regulations the expression "petroleum" shall mean the petroleum to which the Petroleum Act, 1871, applies, provided that when any petroleum other than that to which the Petroleum Act, 1871, applies, is on or in any light locomotive or is being conveyed or kept in any place on or in which there is also present any petroleum as above defined, the whole shall be deemed to be petroleum as above defined.

1. Petroleum shall not be kept, used, on conveyed, except in tanks or cases of metal so made and closed that no leakage, whether of liquid or vapour, can take place therefrom, and so substantially constructed as not to be liable, except under circumstances of gross negligence or extraordinary accident, to be broken or become defective or insecure in course of conveyance or use; and every air inlet in any such tank or case shall be at all times, except when the valve, if any, is required to be removed for immediate use or repair, protected by securely affixed wire gauze, the openings in which shall not be less in number than 400 to the square inch.

2. Every such tank or case shall be clearly stamped or securely labelled with a legible metallic or enamelled label with the words "mineral spirit, highly inflammable, for use with light locomotives."

3. The amount of petroleum to be in any one such tank or case at one time shall not exceed 20 gallons.

4. There shall not be at the same time on or in any one light locomotive more than two of such tanks as aforesaid.

5. Before repairs are done to any such tank or case that tank or case shall, as far as practicable, be cleaned by the removal of all petroleum and of all dangerous vapours derived from the same.

6. When petroleum for use in or in connection with any light locomotive is not being so used it shall be kept either in accordance with the provisions of the Petroleum Acts, or in such tanks or cases as aforesaid; provided that the amount of petroleum which may be so kept in tanks or cases as aforesaid shall not exceed the amount of petroleum which may be kept on or in any one light locomotive at the same time, and that the tanks or cases shall be kept in the open air or in some suitably ventilated place.

7. The filling or replenishing of a tank with petroleum shall not be carried on, nor shall the contents of any such tank be exposed by artificial light, except a light of such construction, position, or character as not to be liable to cause danger, and no artificial light shall be brought within dangerous proximity of the place where any tank containing petroleum is being kept.

8. In the case of all petroleum kept or conveyed for the purpose of or in connection with any light locomotive (*a*) all due precautions shall be taken for the prevention of accidents by fire or explosion, and for the prevention of unauthorised persons having access to any petroleum kept or conveyed, and to the vessels containing or intended to contain, or having actually contained the same; and (*b*) every person managing or employed on or in connection with any light locomotive shall abstain from every act whatever which tends to cause fire or explosion, and which is not reasonably necessary, and shall prevent any other person from committing such act.

9. These regulations shall come into operation on the 14th day of November, 1896, and be in force until further notice.

Whitehall, November 3, 1896. M. W. Ridley.

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UNDERGROUND ELECTRIC EXPRESS.

The following is Sir Benjamin Baker's report on the proposed electric railway between the Mansion House Station and Earl's Court. It is a good augury that such an eminent engineer should advise the Metropolitan District Railway Company to adopt electric traction on the proposed new line. We trust that the difficulty arising over changing from steam locomotives to electric at Earl's Court will be got over by the employment of electric locomotives over the whole Metropolitan system.

2, Queen-square-place, Queen Anne's-mansions, Westminster, S.W., October 13, 1896.

District Railway (Electric Express).

Gentlemen,—In accordance with the instructions received by me at the Board meeting of the District Railway on September 29, I have carefully studied the question of constructing an electric express line under the existing District Railway, and now submit my report, plans, and estimates.

Description of Line.

At the Board meeting aforesaid it was considered essential that trains from Hammersmith, Putney, etc., should be able to run through by the express route to the City so that the necessity of passengers changing trains at Earl's Court might be avoided. This obviously involved a physical junction of the proposed railway with the existing rails of the District at some convenient point between Earl's Court and Gloucester-road Stations.

The proposed express line, therefore, as laid out by me after detailed consideration of all the conditions of the case, will commence by a junction with the main line of rails of the District Railway about midway between Earl's Court and Gloucester-road Stations, and, curving to the right, will run under the Cromwell-road for a distance of about 300 yards on a descending gradient of 1 in 42, when it will be at a sufficient depth to pass under the side wall of the covered way of the District Railway near to the west end of Gloucester-road Station, from whence it will continue to run under the District Railway to the terminus at the Mansion House.

Having been engaged personally on the construction of the District Railway, I have an intimate knowledge of the soil through which the electric line tunnels would have to be driven, and of the works of the District and other railways, sewers, and buildings over or near to the proposed line. After further detailed study, I confirm the opinion expressed at the Board that under proper engineering supervision and with experienced contractors the proposed works can be carried out without interference with the District Railway or risk of damage to any works or property in the neighbourhood. The tunnels throughout would be in perfectly solid and dry London clay, which is the most suitable soil for such works.

It is proposed that there should be one intermediate station between Earl's Court and the Mansion House at Charing Cross. At Earl's Court the existing platforms would be used by the electric railway passengers. At Charing Cross the platforms for the latter would be 63ft. below the present District Railway platforms, or 78ft. below street-level, and at the Mansion House the corresponding depths would be 71ft. and 95ft. respectively. Hydraulic lifts and stairs would be the means of communication between the platforms of the electric railway and District Railway at Charing Cross and Mansion House, and above that level the existing entrance and exit stairs, slightly modified, would be common to passengers by both lines.

At the most convenient intermediate point between Earl's Court and Charing Cross and between Charing Cross and Mansion House respectively, a 9ft. diameter iron shaft would be sunk to facilitate the construction of the tunnels in the first instance and to serve subsequently as block signal stations and as electric fan shafts for ventilating the new line.

In the working of the line the steam locomotives and electric locomotives would change places at or near Earl's Court Station, and the most convenient way of effecting this has involved a great deal of consideration and discussion. By a readjustment of the existing lines at Earl's Court, and a modification of the traffic arrangements, it would be possible to change engines at the Earl's Court platforms, but as this would indisputably involve some inconvenience and delay to the District traffic I have considered it necessary to provide an alternative, in which the existing arrangements at Earl's Court would be unaffected. This is attained by constructing the first 176 yards of line under the Cromwell-road as a brick-covered way of sufficient size to admit the shunting of a steam locomotive, so that the change of engines might take place clear of District lines. There is no difficulty in this from an engineering or traffic point of view. To meet Board of Trade requirements, as the change of engines would take place on a gradient, the ordinary air-brakes would be supplemented by a rack railway brake on the rear carriage of each train so that no running away could occur even if the air-brakes failed. As regards the time element, I doubt if there would be much difference between changing engines on the District lines at Earl's Court Station and on the electric line a little further east, as the extra stop would be compensated for by the increased facilities of exchange at the latter point and by the stop at Earl's Court being reduced, say, from $1\frac{1}{2}$ minute to 20 seconds. However, my plans and estimates provide for either alternative and the decision may be left for the future.

At Charing Cross the station tunnels have been placed on the east side of the South-Eastern Railway Charing Cross bridge so as to be well clear of the cylinder foundations of that structure. The necessary modifications of the existing stairs at this place are very small.

At Mansion House Station advantage could be taken of the carrying out of the necessary modifications for the electric railway to improve the existing arrangements of stairs.

No property would have to be acquired for any of the preceding works, but in certain places easements would have to be acquired independently of that which could be granted by the District Railway Company.

This question, though probably a small one as regards cost, is a very important one from a legal point of view, as there are many novel questions to be dealt with, and any serious error might imperil the Bill. If there be any intention to proceed with the matter, therefore, it would be desirable that the solicitors and parliamentary agents should consult with me as early as possible with regard to the necessary property plans and parliamentary notices. In some instances the District Railway has been built over and in others it has limited rights in the subsoil, so there may be considerable investigation required before the notices could be prepared.

It would be desirable also that a land surveyor should confer with me, as it will be necessary to schedule some five to ten acres of land for sidings and shops for the electric railway rolling-stock at some place adjoining the District Railway suburban lines. Land also will be required for the generating station as close to Earl's Court as possible.

In drafting the Bill it would be well to disarm opposition as far as possible by adopting practically the clauses as to the construction of the shield-driven iron tunnels inserted in the Central London Railway Act, and as regards the small length of brick tunnel in the Cromwell-road to insert a clause providing that the roadway shall not be broken up for the construction of the works to a greater extent at any one time than one-half the width of the roadway by a length of 100 yards.

Estimate.

In the statutory form of estimates for Parliament nothing is set forth for rolling-stock and plant, nor for professional charges, interest during construction, if authorised, and other expenses, the cost of which is assumed to be provided out of the borrowing powers of one-third of the capital.

I have prepared the estimate, therefore, in the present case in two sections, the first of which includes the items necessarily set forth in the parliamentary estimate, and the second those which in ordinary cases would be provided for out of the borrowing powers :

(1) *Cost of Railway Works and Land.*

Length of line, five miles, double.

Tunnelling and shafts	£745,440
Permanent way, etc.	29,500
Permanent way for sidings	1,360
Stations	25,000
Contingencies—10 per cent.	80,100
	881,400
Land and buildings, including easements, say	118,600
Total	£1,000,000

(2) *Cost of Electrical Installation, Rolling-Stock, etc.*

Electrical installation capable of working eight trains on the line at the same time if required. Rolling-stock, consisting of 10 full-powered electric locomotives, 80 long American-type carriages; also repairing shops and depôt for same, and hydraulic installation and lifts at stations	£264,000
Professional charges, parliamentary and other expenses, and interest during construction, say 15 per cent. ...	189,600
Total	£1,453,000

The preceding estimate, based upon actual surveys and detailed quantities, differs little from the rough estimate of £1,500,000, which I gave at the meeting on September 29 as the probable total cost of the proposed line and equipment.

On an estimate of £1,000,000 for works and land Parliament would, in the case of an electric railway, probably authorise a capital of £1,200,000, which, with the borrowing powers of one-third, would make a total available sum of £1,600,000.

I believe my estimate to be in all respects sufficient, but, as already stated, the sum of £118,600 for land, buildings, and easements requires verification by a competent land surveyor, as it is not based upon an actual valuation of any specific lands to be acquired for the generating station and for the repairing shops and depôt, but it is merely the round sum of £100,000 of my original rough estimate with an arbitrary addition to bring the parliamentary estimate up to even figures.

The triangular plot of land between the Gloucester-road curves would be an admirable site for generating station, but the District Railway Company, I fancy, holds that land under certain restrictions which might prevent its use for such a purpose.

This report is accompanied by small scale plans and sections of the railway. The enlarged plans can be seen, if desired, at my office.—I am, gentlemen, yours faithfully,

Benjamin Baker.

The Metropolitan District Railway Shareholders' Association.

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MOTORCARS.

The restrictions which for years have hampered the development of self-propelled vehicles on the public roads are to be withdrawn to-morrow. The new regulations under the Light Locomotives on Highways Act containing the conditions of the freedom now given appear elsewhere in our present issue. It will be noticed at the first reading that the subject has been approached in a most broad-minded spirit, and that the Local Government Board have not harshly used their statutory powers. It is no slight task to dovetail the new requirements of the motorcar into the old regulations affecting the general vehicular traffic without experience as to what the new cars can do. Hence we note with approbation that the speed regulations are made to hold for the short period of six months. In the Act a maximum speed of fourteen miles an hour was mentioned, but the present regulations reduce this to twelve miles per hour. If, however, the weight of the light locomotive exceeds one and a half tons and is under two tons when unloaded, the maximum speed is reduced to eight miles an hour. For vehicles over this latter weight five miles an hour is to be the limit. A reduction in speed for heavy traffic and also for cars drawing a trailer is only fair in the interests of the public. These regulations can be made more stringent by the local authorities, but we trust these bodies will follow the advice of Sir Hugh Owen, and not use their powers until some experience has been obtained as to the working of the present general regulations. The rest of the conditions to be observed will doubtless be of interest to our readers. The question before us is as to which of the various sources of power will find most favour with the public. The chief competitors comprise electricity, steam, gas, and oil, and the comparison must not be made only from the standpoint of the owner of the self-propelling carriage. Taking first the danger to the general public. Here the use of oil or of compressed gas stand easily first. The risk of explosions elsewhere than in the cylinders cannot be wholly done away with, and that such risks are by no means small is shown by the regulations as to the use of petroleum drawn up by Sir M. W. Ridley. The danger from the use of steam is not appreciable, and with due precautions can be eliminated; while with self-contained cars the use of electricity carries with it absolutely no risk, either to the occupants of the carriage or to the general public. The next point is that of inconvenience to the public. No engineer has yet had the courage to discharge the products of combustion from a gas-engine at a low level in the public streets, and the smell in the engine-room soon gives him warning when the joints in the exhaust-pipes need attention, yet these gases, with both oil and gas driven cars, are to be discharged directly into the atmosphere under conditions really worse than apply with a stationary gas-engine. This will form a serious objection in the streets of a town, although in the country a single car may not vitiate the atmosphere appreciably. The steam carriage labours under somewhat similar disabilities to, perhaps, a smaller extent, while electricity again scores

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heavily. The remaining point of comparison is that of the owner, who naturally considers first cost and cost of upkeep to be of no small importance after convenience, speed, and power to run long distances have been provided. The results of trials up to the present have been rather in favour of oil as a motive power from the owner's standpoint, but the true solution will only be found after more extended use. It behoves makers of accumulators to look carefully into the matter; the electrical engineers must also remember that careful design is needed both in the electrical parts and also in the mechanical gearing. The manufacturer of a commercially successful carriage propelled by electricity will find a large demand even at the present time. This demand will also grow as the freedom of the new Act becomes appreciated, and will further extend the scope of the electrical engineering profession. The Motorcar Club hold their first meet to-morrow, and will celebrate the occasion by a trip to Brighton by road. A representative gathering of self-propelled carriages is expected, and we notice that some half-dozen of these will be propelled electrically.

THE INSTITUTIONS.

The various engineering societies throughout the kingdom are now commencing their winter programmes. The Institution of Electrical Engineers held their opening meeting last evening, when a valuable paper by Mr. J. Gavey on telephone trunk lines was read and discussed. We trust that the Institution has a profitable session before it, and that the high tone of this paper will be kept up by those to follow. Practical papers dealing with practical questions are wanted, but not contributions advertising specialities, and we hope that matters of internal management of the Institution will not take such a large proportion of time as last year. The Northern Society have taken the lead as to date of commencement. Mr. J. S. Raworth's paper brings the Universal engine prominently into notice. Its designer has naturally a high opinion of its capabilities, but our readers must be careful in accepting some of his assumptions as to cost of upkeep and labour, which at present cannot be based on experience. The figures of economy are more firm, but even then a single trial needs confirmation, and trial-trip results are not reached in daily work.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE BLOCK SYSTEM.

Sir,—In accordance with the editorial note which appeared in your issue of October 30, I have pleasure in making some extracts from my collection of early official records relating to the block system, and forward the same as follows:

Mr. (afterwards Sir) William Fothergill Cooke and his coadjutor Wheatstone, immediately after having invented the "electric telegraph," saw its value as a means of regulating and controlling the working of railway trains, and as early as December, 1839, the records of the Great Western Railway Company prove that the inventors induced the directors to have the arrival and departure of their trains telegraphed from station to station between Paddington, West Drayton, and Hanwell, and instructions were given that if a second train should arrive at any telegraph station before the previous train was telegraphed as "arrived," it was to be stopped by the outdoor signals and detained until such telegraph message was received. This was to all intents and purposes the object and spirit of what we designate the "block system."

Messrs. Cooke and Wheatstone in the year 1841 introduced independent instruments for controlling the trains in order to show at a glance if the line was "clear" or "blocked." Upon left-hand top corner of the block instrument they printed the word "stop," and on the right-hand corner "go on." They also provided a brass pin in order to hold over the handle of the instrument and consequently the needle; they further added an electric bell to call attention.

The invention of the "block system" as used at the present day was therefore practically completed by Cooke and Wheatstone in 1841. In 1844 Cooke and Wheatstone put their block system into use between Norwich and Yarmouth, but the instruments instead of having the words "stop" and "go on" had "line clear" and "line blocked." The official records of the old Birmingham and Gloucester Railway Company prove that during the winter of 1843-4 an accident occurred upon the Lickey incline, and that upon the advice of Mr. James E. McConnell, the company's locomotive superintendent, block working was carried out by complete telegraph messages. The following extract from the book used to record these messages is interesting. Blackwell, for instance, telegraphed: "Bristol goods is approaching here." Bromsgrove replied: "Right; let her come." Before the goods train could have reached the foot of the incline Blackwell telegraphed: "The Bristol passenger is approaching"; to which Bromsgrove replied: "Keep her back, goods not here yet." But in a few more minutes a further reply was sent: "Right now; send her on."

When the Midland Railway Company opened their branch from Knighton Junction to Burton in August, 1849, the engineers, Robert Stephenson and Charles Liddell, considered that the incline $4\frac{1}{2}$ miles in length between Bagworth and Desford was so steep that it would not be safe to allow any train to start till the previous one was "clear," and they had the "electric three-wire block" put into force. At each end there was a bell upon the top of the block instrument and two dials, one for "up," the other for "down" trains, each dial having a needle. The official records of the Midland Company show that the code used was as follows:

To call attention	1 stroke of bell	—
Passenger train approaching here	2 strokes of bell	2 beats of needle to left.
Goods train, ditto	3 ,, ,,	3 ,, ,, ,,
The West Bridge train	4 ,, ,,	4 ,, ,, ,,

Upon a train leaving either Desford or Bagworth, the following signals were given:

To call attention	1 on bell ...	—
Passenger train leaving	6 ,, ...	6 on needle to right.
Goods ,, ,, ...	7 ,, ...	7 ,, ,,
West Bridge train ,, ...	8 ,, ...	8 ,, ,,

Upon arrival at either end the signal was given:

To call attention	1 on bell ...	—
Passenger train arrived	— ...	2 on needle to right.
Goods ,, ,, ...	— ...	3 ,, ,,
West Bridge train ,, ...	— ...	4 ,, ,,

The above-mentioned instruments and the same "code" were in use from 1849 to about 1863, when the Midland Company removed the instruments from the station-master's offices, and at the same time put in two of their "single-needle" instruments, and those are working at the same places now. The outdoor signals at Desford and Bagworth were always kept at "danger" except when lowered or turned off for a train to enter upon the incline, and no two trains were allowed to be in the same section at one time. Drivers were instructed to whistle when about half a mile from either Desford or Bagworth—thus, two whistles if a passenger train, three whistles if a goods train, four whistles if the West Bridge train, upon hearing which the first, or "be ready" signal, "train approaching here," was sent on the "block system."

The telegraph engineer of the South-Eastern Railway in

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1851 carried out "block working" by means of a code of rings on the bell, and did not employ dial instruments.

The records of the London and North-Western Railway prove that in 1853 added a third position to the block instruments, and then had "line clear," "train on line," also "line blocked" when the needle was in the vertical position; the telegraph wires were brought down the posts so that in case of a breakdown of a train the driver or guard could run to a post and cut the wire and block either one or both lines as necessary. This improvement was introduced by Mr. Edwin Clark, and the late Sir George Findlay, in his interesting book, states that "Mr. Clark's apparatus took the form of what is known as the 'three-wire' block telegraph for double lines, and this form has held its own up to the present time."

In 1855 the South-Eastern Company's records show that they adopted a form of block instrument having a miniature semaphore signal with two arms instead of needles.

The above few extracts from my official notes prove that the "block system" as used to-day was invented considerably over 40 years ago, and that the claim of a person who says "he invented it in 1865" is perfectly absurd.—Yours, etc., CLEMENT E. STRETTON, C.E.

Saxe-Coburg House, Leicester, October 31, 1896.

SIR,—I very much regret that I am unable to supply exact information concerning the date of the introduction of the block system for the regulation of railway traffic, as requested by Mr. Stretton. I am afraid I have neglected any opportunities of acquiring such information, from being more interested in Omega than Alpha. What information I have, however, is very much at Mr. Stretton's service; he may already have it or not; that, however, I have no means of ascertaining.

I have not the slightest desire to moralise on this question, but it would appear to be one of a class which requires more rigorous definition than has yet been applied to the terms used in describing it. What is meant by "block system"? Is it the preservation of the space limit between successive trains, which is the fundamental object of all block and signalling apparatus, without reference to the means employed, or the degree of perfection attained by its use? If so, the block system may be said to have originated with the old tail disc and fire-grate. These appliances were imperfect no doubt, but they were a means by which a space limit might be preserved if noticed in time.

If the introduction of the block system was coincident with the division of the line, or any portion of it, into sections, with electrical means of communication between the ends, and the provision of persons at each end charged with the mutual control of the section, the instrument shown in your issue of July 3 was a block instrument, as will be seen by a reference to the code accompanying the illustration. I have no means of ascertaining when this instrument was first fixed, but a label on it reads: "24th February, 1862. From Shildon Tunnel, North End, to Mr. R. Brown, superintendent, Darlington"—when it was probably returned for repairs, as the instrument was in use at a later date to my own knowledge. (As this letter deals with history, may I here interpolate a question as to whether the instrument here referred to is not the first instance of the employment of an *induced* needle?)

In the issues of the *English Mechanic* of July 6 and 20, 1866, will be found Parts II. and III. of a series of articles entitled "Train Signalling in Theory and Practice," by Charles V. Walker, F.R.S., F.R.A.S. These articles are supplemented by footnotes "extracted from No. XV., Vol. IV., of the *Popular Science Review.*" In these articles Mr. Walker describes in most minute detail the system of bell signalling in use on the South-Eastern Railway, of which he was the electrical engineer. He there states: "The fundamental law is: 'Two trains or engines are not to be allowed to run on the *same* line between two signal stations at the *same* time.' In order to carry out this important regulation, upon which the security of those who travel so largely depends, 'every train or engine must be signalled *out* to the next station before it *leaves* or *passes* a station.' . . . 'The train or engine must not be started, or allowed to pass, until the next station has *taken* the *out* signal.' It is not enough for the first station to *give* the signal, the other station must *take* it, for 'no signal *given* by one station is complete until *taken* by the other station *repeating* it,' by which process a clear understanding is established between the two signallers that the precise signal *sent* by one is *received* by the other. The next rule applicable is that 'every train or engine that *arrives* at or *passes* a station is to be immediately signalled back *in* to the last station,' and it follows from what has been already stated that 'no second train or engine is to be allowed to follow until the *in* or *arrival* signal of the *previous* train has been taken'—that is to say, has been repeated back blow for blow." "And in order that there may be no mistake as to whether or not the whole of the train is safely in, it is not to be signalled *in* until 'after it has been clearly ascertained by actually *seeing the tail lamps*, or communication with the guards, that no portion of the train from any cause has been left behind." The italics are all Mr. Walker's The "out" signal corresponds with the present "train on line," and the "in" signal corresponds with the present "train cleared section" signal.

The extracts given above describe a complete block system by means of bell signals alone, and one which if strictly adhered to is as safe as any system in use at present. Mr. Walker, in the parts available, gives no direct date of introduction, but "on the day of the Foresters' *fête* (August 19, 1862) no less than 535 trains were signalled at one intermediate station in the London Bridge yard on one pair of bells . . ."

Again: "The simplest case of deviation from 'a general code' of signals is when the trains of two companies travel on the same lines, as the South-Eastern and the Brighton trains between London and Redhill. In this case one blow indicates a South-Eastern train, whether up or down; and two blows a Brighton train, all other signals remaining unchanged; or to take a case somewhat more complex and which is the oldest of the codes, *dating as far back as October 29, 1851*, and provided originally for up trains on the half mile of line intervening between Spa-road and the entrance to the joint station at London Bridge, one blow for a Croydon train, two for a Brighton train, three for a South-Eastern train." The italics in the last extract are mine.

These extracts indicate, I submit, that a most carefully thought out system of block working existed on the South-Eastern Railway in 1851.—Yours, etc., J. PIGG.

OPENING AT BURY.

The Bury electricity supply works, a description of which appeared in our issue of last week, were formally opened on Thursday, 5th inst., a large and representative gathering of townspeople being present to see the light switched on by the Mayoress (Mrs. J. Hall).

The MAYOR (Alderman Hall) conducted the proceedings, and, in declaring the station opened, referred to the delay which there had been in adopting electric lighting in Bury. It had been talked about for a great many years, but he thought those present would all agree that nothing had been lost by waiting, since the latest improvements had been embodied in both buildings and plant. The various apparatus with which the station was equipped was much more efficient than would have been the case a few years back. He had great pleasure in calling upon the chairman of the Electric Light Committee (Councillor Ashworth) to start the first engine.

The first engine was then started by Councillor Ashworth, and the second by the Mayor, cheers being raised as the machines were set in motion.

At this point Councillor ASHWORTH ascended the switchboard gallery and asked the Mayoress to switch on the light, at the same time expressing his hope that the electric light in Bury would prove a great success, and that the supply of the electric current for lighting and heating purposes would assist in bringing success to the business of the town. The Mayoress then switched on the light amidst prolonged cheering.

With a few appropriate remarks, Mr. ALEXANDER SIEMENS, the contractor for the plant, then presented the

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Mayoress with a handsome statuette in bronze fitted with a graceful pendant electric lamp, and bearing the following inscription on a silver plate : "Presented to the Mayoress (Mrs. J. Hall) by Messrs. Siemens Bros. and Co. upon the occasion of her switching on the light at the opening of the municipal electric supply station, November 5, 1896."

The MAYORESS expressed her thanks to Messrs. Siemens for the handsome memento and to the Corporation for inviting her to perform the ceremony which it had been her pleasure to perform that afternoon.

Subsequently, Alderman Brierley presented Councillor Ashworth with a similar memento from the members of the Town Council in recognition of his services as chairman of the Electric Light Committee.

Councillor ASHWORTH said he hardly knew how to sufficiently express his thanks for the kind mark of appreciation bestowed upon him by the Council for his services in connection with the electric lighting undertaking, but the handsome statuette would always be highly prized by him.

Formal proceedings being then concluded, the guests were entertained by the Mayoress, an excellent programme of music being rendered by the Oxford Band while light refreshments were partaken of. Congratulations on the success of the opening were exchanged all round.

Subsequently, during the evening a banquet was held in the Town Hall, about 100 guests assembling. Councillor Ashworth (chairman of the Electric Light Committee) presided. An excellent repast was partaken; and after full justice had been done to this, and the usual loyal toasts duly honoured, Mr. A. SIEMENS rose to propose "Success to the Electricity Works." In doing so, he said he was confident of the success of the works which they had just completed. There were one or two things which it was necessary to observe if they would make their electricity works a success. In the first place, the works ought to be properly designed and constructed ; in the second place, they ought to be properly equipped ; and in the third place they ought to be properly carried on. He spoke also at some length as to the advantages which electric light offered over other artificial illuminants, and called attention to the unreliability of comparing the cost of the two rival illuminants—electricity and gas—respectively without taking facts other than the mere relative cost on paper into account. He coupled with the toast the name of Councillor Ashworth.

Councillor ASHWORTH briefly responded, thanking Mr. Siemens for the kind manner in which he had proposed the toast. He also thanked Mr. Siemens for the advice which he had given.

In a humorous speech Mr. CRAWFORD (Messrs. Belliss) proposed the toast of "The Engineers," coupling the toast with the names of Mr. Cartwright and Mr. Lacey, to whose abilities as engineers in their respective capacities he paid high tribute.

Mr. CARTWRIGHT, in responding, said that from observations he had made and the attention he had paid to the subject he was convinced that there were greater possibilities and probabilities for the uses of the electric current than had yet been brought before their notice. He had faith that there was a great deal to be obtained from the use of the electric current. He did not think there could be two opinions on the point as to whether or not the Corporation should have undertaken the work of electric supply or left it to a private company, because it had been proved that corporations which had allowed private companies to instal the electric light regretted now that they had done so.

Mr. LACEY also responded, remarking that electricity was a much more healthy light than gas. He also mentioned that machinery could be worked more economically by electricity than by steam, by adopting the separate motor system.

Mr. L. HOLMES, of Newcastle, gave the toast of "The Mayor and Corporation of Bury." He referred to his pleasant associations with the Bury Electric Light Committee in years past.

The MAYOR thanked Mr. Holmes for the manner in which he had proposed the toast. He believed that the electric light undertaking would pay sooner than many people thought, because they knew that as soon as one shopkeeper saw that by means of the electric light his neighbour's goods were shown off to better advantage he would want the electric light as well.

Dr. MELLOR proposed the toast of "The Chairman," which was responded to by Councillor ASHWORTH, who in concluding his remarks expressed the thanks of the Corporation to the Mayoress for switching on the light and for entertaining a large company that afternoon.

The proceedings, which we may add were happily relieved with songs and music, thereupon terminated.

CROYDON ELECTRICITY WORKS.

The inauguration of the electric supply at Croydon took place on the 6th inst., as was mentioned in our issue of that date. The chairman of the Electric Light Committee invited a representative company to witness the ceremony. The station was open for inspection at 7.30 p.m., the approach to it along Factory-lane being decorated by two paraffin lamps. These were sufficient to mark out the footpath, and made a great contrast with the lighting in and around the buildings. After the station outfit had been admired, the company gathered into the meter-room to hear a few short speeches.

The CHAIRMAN (Alderman Miller) said he was most pleased to welcome those present to the electric lighting works. He had been an advocate of the municipalisation of the electric light for many years, and felt proud to be able to ask the present Mayor to switch on the public supply that evening. Of the many important improvements in the borough completed under the Mayor's supervision, he considered the present venture to be by no means the least important. The opposition from the gas interests in Croydon had been keen, but he would console his opponents with the fact that healthy competition would improve rather than depreciate their property. He then called upon Prof. Kennedy to say a few words as to the method of working and the principles employed.

Prof. KENNEDY thought the five minutes allowed him to be rather short for a full description of the plant and the general theories of electricity. He was very glad indeed to be present at the opening of the works, the completion of which was a credit to all concerned. The preliminary running had been carried out without the slightest breakdown, which was greatly to the credit of Mr. A. Fell, the contractor's engineer. He then gave a short popular account of the actions going on in the alternators. With regard to the street-lighting, he considered that the Corporation were quite right in the plan they had followed. Well-lighted streets increased the prosperity of the town, and also that of the electric supply department, in more ways than one. The competition between the internal lighting of the shops and external lighting in the streets tended to increase the consumption of both electricity and gas ; also in some places the light entirely altered the character of the streets of an evening. Thus, in Edinburgh, certain streets had recently become fashionable promenades of an evening due to the new illuminant.

Alderman MILLER then called on the Mayor to declare the works open.

After a short speech from the MAYOR the Mayoress switched on a street-lighting circuit, in series with which was connected an arc lamp in the room. In order to actuate the switch a gold bracelet had to be pulled, which bracelet was presented to the Mayoress by the British Thomson-Houston Company in honour of the event.

The street-lighting was supplied for the time being from a Thomson-Houston arc-lighting dynamo, belt-driven from one of the alternator flywheels, but after this week it is expected that the Ferranti rectifiers will be ready to take over the load.

Two interesting features of the Croydon plant were not referred to in our last week's issue. The first is the fact that on light load the motor alternator, which is coupled to the direct-current dynamo for charging the accumulators, will be used to supply the idle current. The accumulator will then act as the source of power, and an economy in labour will thus be effected, as in the summer two shifts of men

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can be saved. The other feature of general interest is the construction of the high-tension fuses used in the sub-station. These fuses, which can be seen in the illustration, consist of fine wire drawn into thin indiarubber tubing. The tubing used is similar to that employed for insulating wire in instrument connections. The number of these wires is, of course, varied with the current to be carried. It is found that this type of fuse will always break the circuit without damaging anything in the neighbourhood. As a rule, even the rubber tube is not ruptured.

ON CHEAP STEAM POWER.*

BY J. S. RAWORTH, MEMBER.

The main muscle of civilisation is the steam-engine. Steam supplies the power and man directs it. The price at which steam power can be supplied is the principal factor in determining at any moment the degree of domination which man may exercise over the world in which he lives. These are facts which, when they may be in danger of being forgotten by the general public, will still shine brightly in that atmosphere which I trust may at some not distant day be called the fair firmament of Manchester. When that day comes, as it undoubtedly will, when the mayor and Corporation having awoke to the knowledge that smoke and smuts no longer contaminate the air they breathe, and on the strength of that knowledge restore to the town hall the natural colour of its stone, you will enjoy the felicity of feeling that you, with your electricity, have been the main movers in that marvellous metamorphosis.

Considering the vital importance of this subject to the world generally, and to Great Britain in particular, it is somewhat strange that we have never been treated to a Royal Commission to enquire whether we engineers were really doing our level best to put this country in a position to obtain the highest possible return in power for the expenditure of its native treasures of coal and labour. The difficulties of determining in any particular case the conditions of maximum efficiency have, however, been so great, owing principally to the preponderating influence of local circumstances and to the great difficulty of making accurate tests, especially with small engines, that one cannot imagine even a Royal Commission coming through such an enquiry with much *eclât*. It may appear to the builders of large engines, such as are used in Manchester and Bolton, that the problem is not so seriously complicated after all, and it may be admitted that their section of the problem is fairly simple—the conditions being practically alike in all cases. But there are more small engines than large ones, and it is highly probable that in aggregate power the small engines far exceed the large ones. Large engines have had expended upon them much skill and ingenuity, and in consequence have attained a high degree of excellence, but small engines, until electricity came on the stage, were like gutter children—neither understood nor cared for, and yet they take more than their share of the coal-bill of the country.

The cost of steam power is made up of several main elements, which may be stated as follows: (*a*) coal per horse-power hour; (*b*) labour per annum; (*c*) maintenance—oil, stores, ordinary repairs, etc.; (*d*) interest on capital; (*e*) depreciation (amortisation); (*f*) direct and consequential cost of breakdown. It is obvious that the last item (*f*) cannot be expressed in figures, but it is nevertheless a serious and important one, and the items (*d*) and (*e*) are often inflated in the hope of diminishing it. Water is not included, as it is commonly obtained free, or at a very small cost. These five principal items of expenditure, although stated separately, are to some extent inter-dependent. (*d*) and (*e*) Interest and depreciation being fixed charges on capital may be bracketed together at 10 per cent. on total prime cost of engines, boilers, land, and buildings. (*a*) Coal usually grows less as (*d*) and (*e*) increase, but not in any well defined ratio. (*c*) Maintenance, on the other hand, has a tendency to increase with refinement and elaboration in detail.

The relative importance of the several items depends entirely on the amount of power developed per annum—in short, on the load-factor. The variations which occur in practice are so great that it must suffice to take two well-known cases: (1) cotton-mill engine working 2,700 hours per annum at 90 per cent. of full power; (2) electric light engines working at full power 500 hours per annum. The first instance gives us a load-factor of

$$\frac{2{,}700}{8{,}760} \times \frac{90}{100} = 27{\cdot}7 \text{ per cent.}$$

The second gives us a load-factor of

$$\frac{500}{8{,}760} = 5{\cdot}7 \text{ per cent.}$$

Both at first sight appear ridiculously small, but it is doubtful whether a much larger load-factor than that of the cotton-mill example is ever obtained, except in the isolated cases of some factories which work night and day, and occasionally with pumping engine. The figures for the two examples work out as below.

EXAMPLE No. 1.—Cotton Mill—1,000 h.p. Corliss.

Total capital expenditure = £10,000.

		Total cost.		Cost per I.H P. hour.
(*a*)	Coal at 2lb. per I.H.P. and 10s. per ton	£1,084	......	·105d.
(*b*)	Labour	243	......	·024d.
(*c*)	Maintenance	250	......	·025d.
(*d*) (*e*)	10 per cent. on £10,000	1,000	......	·100d.
		£2,577	......	·254d.

Even in this case the capital charge is about equal to the coal and labour combined.

EXAMPLE No. 2.—Electric—1,000-h.p. Corliss.

Total capital expenditure on steam power only = £16,000.

The increased cost over example No. 1 is due to the subdivision of power and increase in size of buildings.

		Total cost.		Cost per I.H.P. hour.
(*a*)	Coal at 4lb. per I.H.P. and 10s. ton	£445	......	·215d.
(*b*)	Labour	475	......	·225d.
(*c*)	Maintenance	500	......	·24d.
(*d*) (*e*)	10 per cent. on £16,000	1,600	......	·76d.
		£3,020		1·44d.

The basis of the calculations are assumed to be as nearly alike as practicable—that is to say, the engine, boilers, buildings, and coal are taken to be similar in efficiency, style, and relative cost. In the second example the horse-power hour costs six times the sum that it costs in a cotton mill, and the item of capital charge is multiplied by 7½. Moreover, the charge for capital exceeds all the other items by 13 per cent. The most striking feature of these two examples is the item of coal; in a cotton mill it is the predominating factor of cost, but in an electric lighting station it only stands at 14·7 per cent. of the total charges. At first sight, therefore, anyone might think that, although economy in coal may be desirable in a cotton mill, it is of little importance in an electrical lighting station; but this is not so. Mr. Crompton, in one of his always excellent papers, read in April, 1894, before the Institution of Electrical Engineers, said: "I agree with Prof. Kennedy that the importance of the cost of fuel used on electrical energy supply works is not to be measured merely by the money spent on the fuel itself, but that it is to a certain extent a measure of the quantity of plant that must be employed, and so affects the cost of upkeep of the plant, and to some extent every cost item except, perhaps, management and profit." I am prepared to go a step further, and to say that it affects those items also. In other words, an increase in the coal bill means an increase in boilers, pumps, pipes, economisers, flues, and labour; the only item which is not increased is the cost of the engine itself, for no doubt can be entertained that a wasteful engine does not cost more than an economical one: it usually costs less.

We now come to the practical question, Can the cost of steam power be reduced; and if so, how? The papers read before this society during the last session, and the discussions thereon, demonstrated most clearly that your members have a firm grasp of the subject, and consequently that it would be sheer waste of time to bring this most important question before the society without attempting to provide an answer which may at least enable you to realise in some practical and tangible form the aspiration of all engineers and manufacturers after cheap steam power. This is the object of the paper. The two examples given above are intended to be as nearly as possible typical of two power plants working with similar engines under widely dissimilar conditions. We now proceed to enquire what improvements are possible and how those improvements can be effected. Considering the fact that at present the capital charges amount to about one-half of the total cost of steam power, it is obvious that economy in coal obtained by means of increased capital outlay is not likely to have much beneficial effect. That this factor in the equation is fully understood in Lancashire is shown by the statement of Messrs. Hick, Hargreaves, and Co., whose opinions naturally and very properly carry great weight: "That in the majority of cases the saving of fuel to be gained by the use of even triple-expansion engines would not balance the accompanying disadvantages, such as extra first cost, greater complication, and consequent risk of breakdowns." With this opinion before us, which is in absolute conformity with the teaching of the two examples quoted, it may be assumed that the improvement aimed at must be gained by a diminution either of all the items of cost or at least of some without increase of the others. It may also be observed that with regard to our indefinable item (*f*) Messrs. Hick, Hargreaves, and Co. consider that the risk of breakdown increases with complication.

* Paper read before the Northern Society of Electrical Engineers, November 10, 1896.

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At this point it is necessary to consider exactly how much power can be obtained from a given quantity of steam—we might even go further and say "from a given quantity of coal," but that would open up a field far too wide for one evening's work. Record figures are useful as a basis of comparison, and although they may not ordinarily be realised in practice, they stimulate mental activity and tend to improve results all round. Whenever an existing record is surpassed, we may conclude that the engine tested possesses all the good points of its predecessors, and at least one special one of its own, and if we can succeed in defining the exact nature of that special improvement, then we may conclude that engineering science has advanced at least one step. The standards of steam consumption per indicated horse-power, as they are generally understood to-day, are as below, subject, of course, to those corrections which the varied and highly critical knowledge of the subject possessed by members of the society will naturally suggest:

	Con-densing.	Non-condensing.
(a) Vertical compound moderate speed	18·5	24·5
(b) Ditto, high speed	17·0	22·0
(c) Vertical Corliss slow speed	15·5	21·0
(d) Horizontal Corliss	14·5	20·5
(c) Triple Corliss	12·5	—

This list of five different types comprises examples of the principal style of engines now in general use; it may be fairly stated of them that as they increase in economy they increase also in cost—the apparent economy is not all real, because, speaking generally and without regard to any particular case, the mechanical efficiency falls off as the thermal efficiency rises. Unfortunately the exact efficiency of large engines is very difficult to determine, but from the available data it may be taken that the best examples do not surpass 92 per cent., and the worst do not fall below 86 per cent.

The increase of cost with increase of economy is by no means regular, neither is it as great as might be expected, having regard to the engine alone; the Corliss engine is, for its size and weight, a cheap engine to build, and if the flywheel be left out of the calculation it is probably no more costly than its smaller and quicker competitors. In this it resembles man's first and fastest friend—my lady fair—who costs little and eats less but wears all she can get. Flywheels, foundations, and fancy framing, all very expensive, go to swell the cost of installing a Corliss engine. It will be noticed that the Corliss engine, in its several forms, leads the list in economy of steam, and although several fitful attempts have been made by its rivals to equal its performance, they do not succeed in carrying off the palm of its well-earned popularity. The Corliss engine in this country dates from the year 1863, and half a page of its history is necessary to show why it came and why it stayed. Prior to its advent, mill engines, and indeed all engines, so far as they were governed at all, were governed by the Watt governor and throttle valve, which gives but poor results mechanically, and with single-expansion engines is a particularly wasteful arrangement. There did not exist at that date a single form of automatic expansion gear suitable for large engines; the millowner had therefore no option but to adopt throttle governing, which was both bad and wasteful—so when the Corliss engine arrived, with its excellent facilities for perfect governing and automatic expansion, it soon became first favourite—it had absolutely no rival worthy of consideration. Increasing boiler pressure only tended to emphasise the peculiar advantages of its admirable valve gear. It is very curious to note that while the real virtues of the Corliss engine are little spoken of, there is no end of admiration foolishly wasted on the peculiarly regular and square-cornered diagrams which it produces, but facts have dispelled this illusion. Engines with no diagrams at all, so to speak, have run it very close, and even the common throttle-valve beats it at low loads. Under these circumstances one must look further and deeper for the cause of its exceptional economy. These causes, I believe, may be summed up under the two heads of small clearance and good drainage. The loss from clearance is a very serious one to engines fitted with piston-valves, especially when the stroke is short. The clearance may easily be as much as 15 per cent. of the volume swept by the piston. Happily the pure clearance loss is definite, and may easily be calculated, but there is an indefinite loss connected with it which cannot be so readily summed up—that is, the initial condensation due to increase of exposed surface, of the worst kind, moreover, for it is swept alternately by the live and exhaust steam.

The Corliss valve reduces the clearance very considerably, so much so that it is possible in long-stroke engines to reduce clearance to about 3 per cent. In the matter of drainage the Corliss engine also maintains its superiority. A vertical engine with piston or slide valves has no natural drainage, and if it were run very slowly would fill up with water, and under any conditions of speed there must always be some water present. Any water carried up by the piston on the up-stroke will be delivered into the exhaust-port and retained by compression until it is met by the high-pressure steam, when it will be blown back into the cylinder. This defect exists also, but to a smaller degree, in a vertical Corliss engine, and prevents it achieving the same degree of economy as the horizontal pattern, in which the exhaust-valves at both ends of the cylinder are placed at the lowest points. In these engines the exhaust-valve has a considerable capacity, and any large volume of water coming over with the steam will be swept into it and discharged at the next stroke, instead of being blown back into the cylinder.

With all these advantages in favour of the horizontal Corliss engine, advantages which are costly in price of engine, buildings, and foundations, how can it be possible for any other type of engine to reduce the total cost of steam power? In the first place, I should remark at electric lighting stations working under peculiar conditions, very uneconomical engines, if cheap and small, will probably be more economical on the whole than the highest class of Corliss engine, provided that one engine and dynamo of a size suited to the day load shall have the highest known efficiency, thermal and electrical. That particular set of plant may work 18 hours out of the 24, and will repay any reasonable expenditure of capital on its construction, but the full load plant works such a short time per diem that economy in first cost, including boilers, becomes the first consideration. These facts are so fully appreciated by members of this society that I should not have dared to trespass on their time by reciting them but for the absolute necessity of making a paper of this kind logical and coherent. To indulge in aspirations after better things may be evidence of a devout mind, but unless some way be made evident by which those better things may be attained the result is not likely to be immediately beneficial to the human race. The members of this society are fully aware that an idea which has quite lately appeared on the face of this globe for a novel method of constructing a steam-engine has selected one of your members as the medium of its incarnation, and as that idea has received the unqualified approval of many leading lights of the engineering profession, I need not apologise for taking this opportunity of endeavouring to show how that idea may be utilised to hasten the attainment of some of the objects described in this paper.

The construction of the Universal engine is now so generally understood that I need not occupy any time in describing it, more particularly as it is only one part—namely, the leading idea as embodied in its steam cycle and the means employed in effecting it—that has any particular bearing on our subject this evening. The construction of the cylinders, pistons, and valves is applicable to all classes of engines, whether long stroke or short stroke, vertical or horizontal, the modification necessary for a horizontal engine being quite simple. Comparing the arrangement of valves and cylinders with that of the Corliss engine, as being the acknowledged best existing, we find: (a) the clearance can easily be made less for a given length of stroke; (b) the surface exposed to inital steam pressure is also less; (c) the drainage is obviously better in both cylinders and in the receiver; (d) the valves are entirely embedded in or between the cylinders, thus reducing loss by radiation. These palpable facts all point to an increase of economy; how great it is difficult to say; the margin between the actual Corliss compound using 14½lb. of steam per indicated horse-power and the theoretical engine working under similar conditions is about 6lb., or 41½ per cent. There is therefore most obviously plenty of room for improvement.

As regards actual facts derived from careful tests of the Universal engine, there are at present only a limited number, but they have been taken from exceedingly small engines. The published figures were obtained from an engine having a 14½in. high-pressure cylinder by 6in. stroke; the consumption at 45 h.p., with 140lb. boiler pressure, was 19·8lb. per indicated horse-power. After the trial the high-pressure clearance was found to be excessive, and the piston was lowered ⅜in., which reduced the consumption to 19·3. This diminution of clearance did not alter the area of exposed surfaces. I believe, subject of course to correction, that this figure of 19·3 is a record figure for any size of engine, and it may certainly be expected to improve in larger engines and under more favourable conditions, for during the test we had 88ft. of steam-pipe in circuit, of which 44ft. were unclothed. The theoretical consumption for the conditions of the trial is 16¼lb., leaving a margin of only 16 per cent. This, however, must not be directly and rigorously compared with the 41½ per cent. mentioned above, as it is well known that non-condensing engines can more easily get a higher percentage of their theoretical possibility than condensing engines. It is unfortunately extremely difficult to find examples of the steam consumption of first-class engines, except Willans's working non-condensing; in fact, the only one I have been able to find is Mr. Hammond's test at the Leeds station of a Corliss engine by Messrs. Hick, Hargreaves, and Co. The indicated horse-power was 405, and the steam used per indicated horse-power 20·31lb. The theoretical consumption was probably about 16¼lb. It is worthy of remark that the consumption obtained in this trial coincides as nearly as possible with Willans's results under apparently similar conditions. The above-mentioned results obtained with a very diminutive Universal engine, com-

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bined with the structural advantages described, under the heads *a*, *b*, *c*, and *d*, above all tending to increase economy do, I believe, justify the expectation that this steam cycle, and the means whereby it is obtained, will, when applied to large engines, effect a very considerable saving of steam.

It now remains for us to consider whether the cost will be increased or diminished. I say unreservedly "diminished." Assume for one moment that the cylinders be applied to any existing design of compound Corliss engine. The first result is to reduce the number of valves from eight to four, and of valve-boxes from four to two. The high-pressure cylinder and piston cost no more than the present tail rod and guide, and at the same time the cost of the low-pressure piston and cylinder is reduced, whilst lagging, cylinder cocks, and other trimmings come down from pounds to shillings. This is the least effective case; all we can say for it is that it will be in some degree both better and cheaper. Now take the triple-expansion engine, in which there is an acknowledged saving in steam of about 12 per cent. at similar pressures. This, however, in a Corliss engine involves four cylinders, eight valve-boxes, and 16 valves, with other gear to match—but with the Universal cycle there are still only two valve-boxes and four valves—in fact, the triple engine is distinctly more simple in construction than the two-crank compound, and can be made for the same price. The saving in the cost of a triple-expansion engine would, therefore, obviously be very considerable. There is yet one step more: shorten the stroke and make the engine vertical—that is, if you like; if you don't like, don't; rest satisfied with the advantages aforesaid. But there are further advantages to be gained by short stroke and vertical position: first, no loss of economy as heretofore; second, no unequal wear of cylinder; third, perfect lubrication by simple means; fourth, increased mechanical efficiency; fifth, reduced cost of engine; sixth, reduced cost of foundations and buildings; seventh, greater facility of repair; eighth, reduced cost of flywheel and gearing. Every item of cost reduced, and with a possible, or rather probable, saving of steam with a triple engine, a certain saving.

Now we turn to our original tables of costs and substitute the following figures, which I leave to your intelligent criticism.

EXAMPLE No. 1.—Cotton Mill—1,000-h.p. Universal.
Total capital expenditure, £7,000.

(*a*) Coal at 1¾lb. per I.H P. and 10s. per ton	£950
(*b*) Labour	225
(*c*) Maintenance	150
(*d*) 10 per cent. on £7,000	700
(*e*)	£2,025

0·2d. per H.P. hour, saving 20 per cent. = £552.

EXAMPLE No. 2.—Electric—1,000-h.p. Universal.
Total capital expenditure on steam power only £10,000.

(*a*) Coal at 3lb. per I.H.P. and 10s. per ton	£334
(*b*) Labour	250
(*c*) Maintenance	300
(*d*) 10 per cent. on £10,000	1,000
	£1,884

0·9d. per H.P. hour, saving 37½ per cent = £1,136.

Having now dealt with the cost of steam power in two well-defined cases, both being on a comparatively large scale, it is desirable to revert for a few moments to the statement made in the opening of the paper—namely, that there are more small engines than large ones, and that they take more than their share of the coal bill of the country. My opinion is that any measure of reform in steam practice to be in any sense universal in its operaton must be applicable to small engines as well as large ones. Last year Mr. Lindley said on this subject: "It would not have been difficult to make small copies of the slow-speed mill engine." This statement may be perfectly true in the abstract, but the practical difficulties surrounding it are commercially prohibitive. The fact remains that all small steam-engines at present in use up to about 50 h.p. are decidedly wasteful, and from that power up to 100 h.p. they are much less economical than the Lancashire mill engine. The Willans engine is an exception to the general rule, but sundry considerations have militated against its general adoption for ordinary industrial purposes. Take the case of a 40-h.p. engine driving a mechanics' shop, with, say, a 12in. cylinder by 20in. stroke running at 120 revolutions, or with a 10in. stroke at 240 revolutions. With an average load of 25 h.p. the steam consumption per horse-power is usually at least 50lb. per horse-power hour.

It is not possible to arrive at the total cost of power with anything approaching the accuracy of the former instances, but it may be approximately estimated as follows:

EXAMPLE No. 3.—40-h.p. Engine.
Average load, 25 h.p., 54 hours per week.

Load factor.—$\frac{2,808}{8,760} \times \frac{25}{40} = 19{\cdot}2$ per cent. H.P. hours = 70,200.

Total capital expenditure, £400.

(*a*)	Coal, 7lb. per I.H.P. and 10s. a ton	£110	0	0
(*b*)	Labour, at 26s.	67	10	0
(*c*)	Maintenance	30	0	0
(*d*) (*e*)	10 per cent. on £400	40	0	0
	= 0 84 per H.P. hour.	£247	10	0

Assume now that a similar installation be made with an engine of the Universal type. The only saving in prime cost would be in the boiler, which would be reduced to half the size of the former.

40-H.P. UNIVERSAL.
Total capital expenditure, £360. H.P. hours, 70,200.

(*a*)	Coal at 3lb. I H P. and 10s. a ton	£47	5	0
(*b*)	Labour	67	10	0
(*c*)	Maintenance	20	0	0
(*d*) (*e*)	10 per cent. on £360	36	0	0
	= 0 58d. per H.P. hour = £76 15s.	£170	15	0

It will be noticed that the sum saved, though only a small fraction of a million, is enough to maintain one working-man and his family, or, from another point of view, it is equal to the interest on £2,800 of consols. From another point of view the saving alone would pay for the whole installation in 4½ years.

APPLIED ELECTRO-CHEMISTRY.*

BY JAMES SWINBURNE.

LECTURE IV.

(Concluded from page 496.)

On the other hand, the distribution of acetylene may well be much more simple in proportion than that of coal gas. If it is to be delivered by pipes, its only advantage, as far as distribution is concerned, is that the pipes will be smaller. This would make but little difference in the total cost of distribution, as it only reduces the capital sunk in mains a little. The cost of laying them would not be very much reduced.

The first thing is to get some idea of the cost of calcuim carbide. The estimates given vary enormously, as very little has been published as to actual cost of manufacture. It seems probable, however, that the cost of manufacture—that is to say, the cost of lime, coke, carbons, labour, and energy—taking energy at a ¼d. per kilowatt-hour, will be a little over £6. If water is used, the price comes out a little lower; but, as already explained, water power must not be reckoned upon too much, as rents will probably go up soon. It is best to be on the safe side, so we may perhaps take £10 a ton as the final price of electrically-made calcium carbide, capable of giving five cubic feet of acetylene per pound, packed and delivered on rail, after paying manufacturers' profits and all charges. This seems a low price, and it may be said that the various aluminium works have all the plant ready, and know exactly the cost of manufacture, and have reduced the price as far as it will go already. The business has really hardly commenced, however, and there is little doubt that the processes will be cheapened. At present it is the roughest and crudest method imaginable.

Let us assume the final price to be £10 a ton, and see exactly what its future may be at that figure. Allowing five cubic feet of acetylene per pound, this gives, in round numbers, 18s. per 1,000 cubic feet. Calcium carbide is not acetylene, however. Suppose the treatment with water raises the acetylene to 20s., and that it gives 20 times as much light as coal gas, it would then correspond with gas at 1s. per 1,000 cubic feet. Now let us look at the price of gas. A ton of coal at, say, 10s. gives 10,000 cubic feet of gas; so gas should be 1s. per 1,000 cubic feet. But the ton of coal gives 15cwt. or so of gas coke, which is worth something, and over 100lb. of tar, which is valuable, and 20 gallons or so of ammonia liquor. Some of the 15cwt. of coke is used to heat the retort benches, and labour, etc., has to be paid for, but still the actual value of gas at the hydraulic main is really only a few pence per 1,000 cubic feet, and acetylene has no chance in comparison. The common practice of taking the price—generally the prime cost—of carbide of calcium, reckoning from it the price of acetylene, and comparing it with the price of delivered coal gas is absurd. In addition, the great difference in lighting power comes in when the acetylene burner, though using little gas, is giving a very powerful light. Except in sitting-rooms, people want small lights about their houses, and they want to be able to turn them down at will.

Acetylene may be used for enriching coal gas. Whether it will pay depends very much on the local conditions. Cannel coal is usually employed when enrichment is necessary. The prime cost of gas at any works depends on the price of coal and

* Cantor lectures delivered before the Society of Arts.

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labour, and on the selling price of coke, tar, and ammonia. The cost of scrubbing and purifying would have to be incurred in making acetylene on the large scale, and the cost of distribution by pipes and collection would be about the same in both cases. It is impossible, however, to give any answer as to whether it would pay to enrich coal gas, unless one knows the real cost price of gas in a given case. Thus, to take a rough example, suppose crude gas costs 6d. per 1,000 cubic feet; so that acetylene costs 40 times as much. Adding 3 per cent. of acetylene would about double its lighting power, so that to replace 1,000 cubic feet of gas we would have 500 cubic feet costing 3d., and 15 of acetylene costing over 3½d. It is therefore clear that it will not pay to enrich with 3 per cent of acetylene at these prices. I have not worked out figures to find the best enrichment for each relation of values of acetylene and coal gas, for it seems clear that unless the cost of carbide is much less, or the cost of crude gas much greater than here assumed, there is no chance of its being utilised in that way. A public company does not make improvements if it can help it, and of all public companies gas companies, owing to their constitution and the sliding scale arrangement, are least likely to adopt such methods as enriching gas, even with the by-products of electric lighting companies, who make carbide to get decent load-factors.

In addition to this, gas is not only used for lighting. It is very largely used now for heating purposes, and the incandescent mantle has come to stay, and people with stoves and Welsbach burners would strongly object to having their gas bills doubled and their gas contaminated with a body which necessitates their renewing all their gas fittings and removing all copper and brass taps and couplings.

It does not look, therefore, as if acetylene will compete with gas at present. It may be a different matter in other countries. In the United States, for instance, gas is generally very dear. I had charge of a works in Boston some years ago, and we paid 10s. per 1,000 for gas. One shudders to think what it must cost in outlying districts. The enormous strides made by the electric light in America is not owing to the good electrical engineers, but to the bad gas producers. Perhaps the gas-works are run by the urban authorities; this would account for anything. If sulphate of ammonia does not fetch good prices in America, and if tar distilling and the manufacture of dyes are not brought to the perfection they are in Europe, it is quite probable that acetylene has a much greater future there than over here, especially as in proportion to the inhabitants water power is much more plentiful so that power prices may remain low for a very long time.

The next scheme is to deliver calcium carbide to houses, and let the consumers make their own acetylene. All that is needed is to add water. This sounds very simple. In the beginning of the century gas was to be made on the spot in the same sort of way. All you did was to put coal in a retort and heat it, and off came the gas. Yet this was never practised, except in special cases, and gas never came into use generally until it was distributed by pipes ready for use. There are, of course a few country houses and isolated establishments where they make a fluid they call illuminating gas. Exactly the same thing happened with the electric light. Each house was to have a gas-engine and a dynamo, and generate its own power. Then the next idea was that the accumulators were to be left at the houses with the milk, and changed next day or week or month; but this never came into practice either. These two schemes correspond very fairly with those of distributing carbide for use in generators, and distributing liquid acetylene in bottles. The generators would always be troublesome in an ordinary house. No doubt the light would be much cheaper and better than that of gas, as commonly used, but that is by no means everything. People forget that the average households are controlled by women. Women may understand people, but they are completely wanting in the faculty of understanding things, and they have the unreasoning conservatism and conventionality belonging to the undeveloped mind as seen in boys and savages. A woman hates everything new, and would never understand how to work an acetylene generator until it had been in use for generations, and it was considered part of the duty of a good housekeeper to make good acetylene, as it used to be to make good beer. Of course, even then, it would be done by rule of thumb. There is more than this. The first thing a woman asks when she sees anything new, be it a mousetrap or a telephone, is, "Will it explode?" Now, no one can say on his honour that an acetylene generator won't explode. He does not think it will—in fact, he feels sure it won't, and he sincerely hopes it won't; but an explosion might possibly occur. This settles the matter. The only thing to be done would be to utilise a woman's instinctive hero worship and belief in authority, and to arrange that acetylene generators should be recommended by her clergyman or doctor. I say her doctor advisedly, as she does not believe in other women's doctors.

The plan of distributing liquid acetylene in iron bottles sounds more promising, as very little goes a long way, and the bottles could be connected to the house service by the acetylene company without the women of the house having anything to do with the matter. Acetylene is given off on the addition of water to the carbide, at enough pressure to liquefy in a cold bottle at once, and it might be purified at the same time. It must be remembered, however, that the comparison must be made, as to cost not with gas burned in the ordinary batswing burner, which is generally not even good of its kind, but with the incandescent mantle. If anyone is going to improve his lighting, he will not take up acetylene, as against the incandescent burner, unless it is better. Acetylene gives, for a cubic foot, about three times the light of the Auer burner, so that at 20s. per 1,000 cubic feet it corresponds to gas at 6s. 9d. Gas seldom costs 6s. 9d. per 1,000. Besides, it is easier to put in the Welsbach burners; but if a considerable alteration is to be made, the electric light may be preferred.

All the same, there is a very large opening for acetylene, apart from competition with coal gas. For country houses, and in carriages, omnibuses, trains, and on board ship, it ought to have its own way. One of the chief things wanted is a good burner, that will not give smuts under any conditions.

A good portable acetylene lamp is also much needed. If the lamp generates its own acetylene there is the difficulty of having it attended to properly, at least by maidservants. Even paraffin lamps are seldom in good order where there are no men servants, and the old colza oil lamps never were. There are other difficulties, however. The action of the carbide on the water is so energetic that each time they touch too much acetylene is given off, and some sort of gasholder is needed. I have tried mixing alcohol with the water to reduce the vigour of the action, and it works fairly well. I have lately found that this plan has been already fully worked out. Another difficulty is that the water gives off vapour which generates acetylene, so that when the lamp is out of use acetylene is being generated slowly. This means that the lamp will smell, and the smell of acetylene is not pleasant.

Small bottles of liquid acetylene for portable lamps should be no more difficult to deal with than mineral-water siphons, and a small steel tube bottle would run a light and portable 10-c.p. lamp for a long time. The want of portability is the great drawback to gas. The electric light is a little better, but not much. The result is that candles are still used. Acetylene lamps would not ruin the carpets, or cement the piano keys together.

Too much has been generally said about the poisonous nature of acetylene. Experiments show that it is not at all a serious poison, and its smell is a great safeguard. It uses so little air in burning that, on the whole, it would be a very much more healthy illuminant than gas, oil, or candles, especially if it contains no sulphur. Healthy breathing is not generally sufficiently appreciated yet. Many people still sit in close rooms and sleep with their windows shut, and the smaller air consumption of acetylene would not really appeal to them very much. Besides, according to experiments recently made on polluted air, the evils of vitiated atmosphere have been greatly exaggerated. Though acetylene, like carbon disulphide, is an endothermic compound, it is not easily exploded. Fulminate of silver only fires it locally. The explosion does not spread. Carbon disulphide explodes under curious conditions. If some is put in a bulb, and an air-pump connected and used, it will go off. I do not know if acetylene has any analogous properties.

Calcium carbide may come to be used in the manufacture of alcohol, benzene, and other organic products, but it is too soon to prophesy its future in these directions. A great deal must depend on its price, and one of the chief items is the cost of electrical power. It is to be hoped that it will soon be made by non-electrical methods, and its price may then be reduced considerably.

COMPANIES' MEETINGS AND REPORTS.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY, LIMITED.

This Company held its thirty-second ordinary general meeting at Winchester House yesterday (Thursday). The total earnings for the half-year ended June 30, 1896, were £71,082. 4s. 9d., being a decrease of £13,854 compared with the half-year to June 30, 1895.

The **Chairman**, Mr. W. S. Andrews, in moving the adoption of the report, stated that this loss of revenue was owing to the diminution of the internal traffic of Brazil. There was a decrease in the working expenses of £463. 0s 5d. The directors recommended the payment of a dividend of £2 per cent. as against 2½ per cent. for the corresponding period last year. This dividend will be 3s. for each share. There was no change in the position of affairs between the Government of Brazil and the Company as to the acquisition of cables.

The report was adopted.

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CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Londonderry.—The Corporation invite tenders for the supply of carbons for one year from January 1 next. Full particulars can be seen in our advertisement columns.

Arlon (Belgium).—Tenders will shortly be wanted at the office of Les chefs de service, Arlon, rue de la Station 36 for a building for an electric generating station at the Marbehan Station.

Belgrade.—Tenders will be received on November 27 for an electric lighting installation at the National Theatre at Belgrade. Application is to the Servian Ministry of Public Works, Belgrade.

Alcazur de San Juan.—The Municipality will receive offers up November 17 for the electric lighting of the town for a period of 30 years. Alcazur de San Juan is in the province of Ciudad Real, Spain.

Malines (Belgium).—Tenders will be wanted for the supply at Malines of about six tons of special lubricating oil for dynamos and gas-engines. Particulars at the Brussels Bourse, where tenders will have to be sent.

Nuremberg.—Tenders will be received up to November 20 for the supply of telegraph posts for next year for the Bavarian State telegraphs and telephones. Application to the Kgl. Oberpostamte, Nürnberg, Germany.

West Looe.—The Parish Council invite tenders for the lighting of the place with gas, oil, or electricity. Full particulars from Mr. Wm. Hicks, hon. clerk, West Looe Parish Council. Tenders to be in by November 28.

South Shields.—The Corporation require tenders for a steam alternator and a rectifier, and extension to switchboards. Tenders are to be delivered by November 23. Specifications, etc., can be obtained at the Borough Electrical Engineer's Office, West Holborn, South Shields, on and after November 9, on payment of £1. 1s. (returnable).

Shoreditch.—The Vestry invite tenders for the supply of insulated wires and mains, insulated iron pipes, junction boxes, main switches, tumbler switches, cut-outs, ceiling roses, etc., for the ensuing year. Tenders and samples to be sent in not later than November 17. Particulars from Mr. C. H. Doughty, lighting engineer, Town Hall, Old-street, E.C. See advertisement.

Hartlepool.—The British Electric Traction Company, Limited, of 1 and 2, Great Winchester-street, London, E.C., on behalf of the Hartlepool Electric Tramways Company, Limited, invite tenders for the construction of the permanent ways. Particulars, specifications, plans, and form of tender may be obtained from Mr. J. Vincent Kitchener, secretary, London, on deposit of £5, which will be returned on receipt of a bona fide tender.

Warrington.—The Cheshire Lines Committee are prepared to receive tenders for the supply during the year 1897 of telegraph materials, instruments, wire, etc. Patterns can be seen and specifications with forms of tender obtained upon application to Mr. S. Saxon Barton, storekeeper, Cheshire Lines, Warrington. Tenders, sealed and endorsed, to be sent to Mr. Glegge Thomas, secretary, addressed Cheshire Lines Stores Department, Warrington, not later than 10 a.m. on November 28 next.

Dublin.—Tenders are required for the supply of general stores and sundries during year ending December 31, 1897, for the Dublin United Tramways Company. Forms of tender (price 1s. each), conditions, and all information can be obtained and patterns seen at the Company's Offices, 9, Upper Sackville-street, Dublin, from 16th to 30th inst. Tenders, sealed and marked outside "Tender for Stores," and addressed to the Chairman, to be lodged with Mr. Wm. Anderson, secretary, by 30th inst.

Paris.—Tenders will be received at the Undersecretariat of Posts and Telegraphs, Paris, rue de Grenelle 103, up to November 26 for the supply of 50,000 cross-pieces with accessories, 315,000 galvanised iron brackets, and about 14 tons of tin solder for the telegraphic service. Application for permission to tender must be made before November 16. Tenders will be received on November 19 at the Chemins de Fer de l'Etat, Paris, rue de Châteaudun 42, for, among other supplies, a quantity of telegraph poles.

Hanley.—The Corporation require tenders for air-compressors (alternative arrangements driven by steam and by electric motors), and alternating-current electric motors at the sewerage works. Full particulars, specifications, bills of quantities, and forms of tender may be obtained at the office of Mr. Joseph Lobley, borough engineer and surveyor, Town Hall, Hanley. Contracts will only be given to firms paying the standard rate of wages. Sealed and endorsed tenders must be sent to the Borough Engineer before Monday night, 30th inst.

Greenhithe. — The Greenhithe and Knockholt Lighting Inspectors require tenders for lighting, cleaning, and extinguishing the lamps in the said district from December 1 next to November 30, 1897, both inclusive (except the months of June and July) from sunset to 1 a.m., for either one, two, or three years at the option of the inspectors. Tenders to state the price per lamp and the proposed method of lighting, and to be addressed to the Lighting Inspectors, Railway Hotel, Greenhithe, and delivered there before 8 p.m. on 24th inst. Mr. A. H. Walter, clerk.

Copenhagen.—Provided the City Council will vote for spending the necessary amount, an electric station is to be built in Vesterbro, Copenhagen, and tenders are invited for the delivery of (1) boilers, (2) mechanical and electrical plant, and (3) network, in accordance with the description. Conditions and plans to be had upon application to the Electrical Station, 30, Gothersgade, Copenhagen. For each specification a fee of 50 kroner is charged, which is returned on acceptance of the tender. Tenders will be received at the office of the fourth division of the Magistracy until December 4 at 12 noon.

York.—The directors of the North-Eastern Railway require tenders for the undermentioned articles, in such quantities as they may require, during the six months ending June 30, 1897, delivered carriage paid at the company's telegraph stores at York: (1) telegraph apparatus; (2) telegraph wires and line stores. Payment for each month's delivery will be made at the end of three clear months, or in cash, less 2½ per cent. discount. Forms of tender may be obtained on application to Mr. Graves, Telegraph Department, York, and tenders must be sent in to the secretary, Mr. C. N. Wilkinson, at York, sealed and marked "Tender for Telegraph Stores," not later than noon on Monday, November 23.

Monmouth.—The Town Council require tenders for the following: (1) machinery (consisting of turbines, alternators, steam-engines, boilers, electric motors, sewage pumps, etc.); (3) cast-iron pumping main; (4) electric lighting mains. Plans may be seen on and after 19th inst. on application to Messrs. Bramwell and Harris, engineers, 5, Great George-street, Westminster, S.W., or to the Town Clerk, Monmouth, from either of whom may be obtained, on deposit of £2. 2s. (to be returned on receipt of a bona fide tender), a printed form of specification and tender for either contract. Tenders, on the prescribed form, must be delivered with the specification attached (enclosed in a sealed envelope), endorsed "Sewage-Disposal, Tender for No. —," and addressed to Mr. T. R. Oakley, town clerk, Monmouth, by 12 noon on November 23.

Derby.—The Midland Railway Company require tenders for (10) telegraph instruments; (10A) telegraph stay rods, bolts, etc., (galvanised); (10B) telegraph and signal wire, etc. Contractors cannot be allowed to submit their own patterns, or tender to supply goods thereto, nor can the company's patterns be sent away for inspection, all being sealed and exhibited at Derby only. The patterns will be ready for the inspection at the General Stores Department, Derby, and forms of tender may be had on application to Mr. G. Morrall, stores superintendent, Derby, care being taken to give reference to the particular contract (by the above numbers) for which it is proposed to tender. Tenders, addressed to the Secretary of the General Stores Committee, Midland Railway, Derby, and endorsed "Tenders for Stores," must be sent so as to be received by 9 a.m. on 17th inst.

Maryborough (Ireland).—Tenders are invited for the supply and erection of an electric light installation at Maryborough District Lunatic Asylum by the Commissioners for the Control of Lunatic Asylums. Tenders should be sent in a sealed envelope, endorsed outside "Tender for Electric Lighting, Maryborough Asylum," and addressed to the Secretary, Board of Control, Customs House, Dublin, and should be accompanied by a separate sealed envelope similarly addressed and endorsed, containing the detailed estimate, by 10 a.m. on 23rd inst. Forms of tenders and copies of specification will be issued on application to the Office of the Board of Control of Lunatic Asylums, Customs House, Dublin, on deposit of £3. 3s., which will be returned to all persons who have sent in bona fide tenders. Plans can be seen at the office of the electrical engineer, Mr. Walter Leake, 35, Dame-street, Dublin.

Ayr.—The Electric Lighting Committee require tenders for the supply and erection of the following plant (the whole bound up in one specification, price £2. 2s, returnable on receipt of a bona fide tender): (Section A) boiler-house plant—two Lancashire boilers and fittings, mechanical stokers, extensions to economiser, feed-pump, steam and exhaust pipes, valves, etc.; (B) engine-house plant—two 200-kilowatt steam alternators and condenser; (C) underground work—cables and culverts. Tenderers are at liberty to tender for either section, but not for part of a section. The ground plans of plant and specification, with terms and conditions of tenders and contract, may be obtained at the offices of Mr. Robert Hammond, the consulting engineer to the Corporation, Ormond House, Great Trinity-lane, London, E.C., on payment of £2. 2s. for each copy, which sum will be refunded on the return of the specification filled up with a bona fide tender. Tenders, sealed and marked "Tender for Electric Lighting," must be addressed to Mr. A. G. Young, town clerk, Council-chambers, Ayr, N.B., and be delivered by November 25.

West Ham.—The Town Council require tenders for the supply of the following: four steam alternators and exciters; surface condenser and pumps; station switchboard, etc.; high and low tension mains, etc.; transformers, sub-stations, etc.; instruments; arc lamps, posts, etc.; crane. Plans of the suggested arrangements, specification, form of tender, and further particulars may be obtained at the office of Mr. John J. Steinitz, borough electrical engineer, Town Hall, Stratford, E., on the deposit of a £5 Bank of England note, which will be returned on receipt of a bona fide tender. Tenders, endorsed "Tender for Machinery, etc.," to be sent to Mr. Fred. E. Hilleary, town clerk, Town Hall, West Ham, by 4 p.m. on November 24. The contractor will be required to enter into a bond, with two sureties, for the performance of contract, and no work will be ordered under the contract until such bond has been duly executed. The contractor whose tender is accepted, and with whom a contract is entered into, will be required to pay the whole of his workmen such rate of wages and observe such hours of labour as are recognised by the workmen's trades unions and in force at the time of signing the contract. In the

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event of any breach of such agreement the Council will enforce the penalty clause in its entirety.

RESULTS OF TENDERS.

Dewsbury.—The Town Council have accepted the tender of Messrs. Crawshaw and Warburton for the supply of coal to the electric lighting station.

Shoreditch.—The Vestry have accepted the tender of Messrs. Atherton and Dolman to carry out the work of erecting the sub-station, the amount being £893.

Kingston-on-Thames.—The Lighting Committee have accepted a tender of Mr. P. H. Dyson for unloading and delivering coal at the electric lighting station at 1s. 2d. per ton.

Brussels.—The lowest tenders for converting local tramways in the neighbourhood of Charleroi for electric working were those of the Societé anonyme Electricité et Hydraulique, Charleroi, and the Compagnie général de traction electrique, Paris. Both tenders were very close together and varied according to the nature of the posts proposed to be erected.

Morley.—The Town Council have accepted the following tenders for the various sections of the work connected with the scheme for lighting the borough with electricity, subject to Mr. Hammond being satisfied with the details of construction of all the work, and certain other conditions:

Holdsworth and Sons, Bradford, boiler-house (two Lancashire boilers, stokers, pumps, and economiser and accessories)	£1,499	5	0
Electric Construction Company, Limited, engine-house (two slow-speed flywheel alternators, motor-alternator, and accumulators)	5,731	0	0
Electric Construction Company, Limited, switch-board and instruments	600	0	0
Bedford Engineering Company, Limited, overhead travelling crane	250	0	0
Callender's Cable and Construction Company, Limited, cables and culverts	1,790	8	3
Electric Construction Company, Limited, transformers and switchgear	822	0	0
Electric Construction Company, Limited, arc lamps and posts	324	0	0
Westinghouse Electric Company, Limited, meters...	114	8	9
Total......	£11,131	2	0

BUSINESS NOTES.

Great Northern Telegraph Company.—The receipts for the month of October were £25,000.

Newport.—The National Telephone Company are about to make several connections in the town.

Rangoon.—The Cantonment Committee are considering a scheme for laying down the electric light.

Ambleside.—The Council at their last meeting considered the electric lighting question in committee.

Halstead (Essex).—The Urban District Council have adjourned the electric lighting question till May next.

Matlock Bath.—The question of electric lighting has been referred to the Sewerage Committee of the Urban District Council.

Guernsey.—The Guernsey Electric Railway Company's sheds at St. Sampson's northern terminus were destroyed by fire last week.

Fareham.—The application of the District Council to borrow £1,900 for purposes of electric lighting is before the Local Government Board.

The Testing of Wires and Fittings.—The City Commissioners of Sewers have fixed the fee for testing consumers' wires and fittings at 10s.

Wimbledon.—The Urban District Council have passed the formal resolution to apply for a provisional order in respect to electric lighting.

Dundee.—The Town Council have authorised the proposed agreement to be executed between them and the National Telephone Company.

Dover.—We learn that the churchwardens of St. Mary's Church are seriously contemplating having the electric light instead of gas in that edifice.

Change of Address.—Messrs. L. Andrew and Co. have removed from 21, Cannon-street to larger premises at 2, Carr-street, Blackfriars, Manchester.

Colwyn Bay.—The District Council have resolved to offer prizes of £30 and £20 for the best scheme for supplying electricity to the district.

Urmston.—The probability of the introduction of the electric light into the district by a company was discussed at the meeting of the District Council.

Huddersfield.—At a meeting of property owners and ratepayers a resolution was passed consenting to the promotion of the Tramways Bill. A poll was demanded.

Redditch.—At the United District Council meeting the clerk was instructed to take steps to obtain a provisional order to enable the Council to light the town by electricity.

Wrexham.—The Rural District Council have decided that they cannot agree to certain portions of their district being included in the Corporation's electric lighting provisional order.

Blackpool.—The Ratepayers' Association have invited Mr. Quin, the borough electrical engineer, to attend a meeting for the purpose of explaining to them the proposed new charges for electric light.

Machinery for Sale.—The Board of Works for the St. Olave District, Southwark, have for sale by tender a dynamo and accumulators. Further details are published in our advertising columns.

Colombo.—The electric light is gradually being introduced into Government establishments, and the Colombo Customs are to be lighted with it. Messrs. Boulstead Bros. have secured the contract.

Southport.—The Town Council have resolved to apply to the Local Government Board for authority to borrow £12,000 for the purpose of extension to the electricity works, machinery, mains, etc.

Mile End.—The Vestry have agreed to oppose the application of the County of London and Brush Provincial Electric Lighting Company, Limited, for a provisional order to supply electricity to the parish.

Chelmsford.—At the meeting of the Rural District Council a letter was read from the Postmaster-General stating that it was proposed to extend telegraphic communication from Danbury to Little Baddow.

Dublin.—The Dublin, Wicklow, and Wexford Railway Company intend promoting a Bill in Parliament for the purpose of obtaining power to use electricity as a means of traction on the Dublin and Kingstown line.

Wells.—At the meeting of the Town Council Dr. Hopkinson's report and plans for the lighting of the city with electricity were referred to the Lighting Committee, who are to report to the December meeting.

Derby.—The Electric Lighting Committee have decided to abolish the meter-rent charge as from Michaelmas, 1896, on condition that a minimum consumption of electricity of 20s. worth per annum is taken.

Birmingham.—The question of lighting the meat market by electricity will be discussed at the next City Council meeting. The lowest tender is that of Messrs. Mavor and Coulson, of Glasgow, at £7,877. 10s.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended November 8 amounted to £1,065, as compared with £1,063 in the corresponding week of the previous year, being an increase of £2.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ended November 6 were £1,929. 4s. 9d., compared with £1,858. 17s. 8d. for the corresponding period of last year, being an increase of £70. 7s. 1d.

Ayr.—It was reported at the meeting of the Town Council that the total works' costs for October was £94. 13s. 2d., while the estimated receipts amounted to £263. 18s. 4d., leaving a balance to interest and sinking fund of £169. 5s. 2d.

Personal.—We have been sorry to hear of the serious indisposition of Dr. Edward Hopkinson, of Messrs. Mather and Platt, of Salford. We understand that Dr. Hopkinson has now been able to get away in order to recuperate his health.

Brentford.—At the District Council meeting the Works Committee reported having considered the letter from Mr. W. H. Druce, of Manchester, with reference to electric lighting. The committee would keep the letter for future reference.

Grange.—The District Council have decided to inform the Board of Trade that they object to any further extension of time within which the deposit required by Section 7 of the Windermere and District Electric Lighting Order, 1895. may be made.

Brighton.—An electricity main is to be laid in West Hill-road at an estimated cost of £91, and another in Bedford-street, from Marine-parade to Bristol-road, at a cost of £48, and the public lamps in these streets lighted by electricity instead of by gas.

Electrical Cabs.—As an immediate result of the Motorcar Act coming into effect on Saturday, arrangements have been made by the London Electrical Cab Company to place a large number of electrical cabs almost immediately for hire in the streets of London.

St. Pancras.—The Vestry have decided that the following districts should be lighted by arc lamps, in addition to the area already lighted by electricity: Haverstock-hill to the parish boundary, Fortess-road and Highgate-road as far as Gordon House-road.

Worsley.—At the United District Council meeting, the recommendation of the Highways Committee, in reply to a letter from Mr. Druce, of Manchester, that the Council should take no action with regard to the electric lighting of the township was confirmed.

Bury St. Edmunds.—In nominating Alderman Lake as mayor of the town, Alderman Gough said that in reference to the contemplated introduction of the electric light, his services would be required in helping to settle how best to deal with the monetary aspect of the question.

Darwen.—We notice that the system recommended by Mr. E. M. Lacey for the electric lighting of this town is the three-wire, with 220 volts between adjacent wires. The erection of a refuse destructor in connection with the electricity works is also advised on the ground of economy.

Kirkby-in-Ashfield.—At the meeting of the District Council, Mr. Shacklock moved that it be an instruction to the Gas and Water Committee to prepare a rough estimate of the cost of lighting the parish with electricity and report to the next Council. Mr. Elliott seconded, and it was agreed to.

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City and South London Railway.—The returns for the week ended November 8 were £1,036, compared with £1,009 for the corresponding period of last year, being an increase of £27. The total receipts for the half-year 1896 were £17,747, compared with £16,658 last year, being an increase of £1,089.

Blackburn.—Mr. Thomas Barton, M.I.E.E., consulting electrical engineer, Blackburn, has published an interesting description of the Corporation electricity works, which were opened on February 18, 1895. Accompanying the description is a plan of a portion of the town, showing the area of supply.

Newark.—Messrs. Gilstrap, Earp, and Co., maltsters, have purchased an electric plant from Messrs. Bailey, Grundy, and Barrett, electrical engineers, of Cambridge, for lighting their malting establishment. The machinery is at present driven by gas, but will in future be driven by electric motors.

Ceylon.—The tramways scheme has a fair chance of being inaugurated after all, according to *Indian Engineering*. The report of the special committee has been adopted, and the Council have agreed to engage Mr. Preece, C.B., F.R.S., engineer-in-chief, Postal Telegraphs, G.P.O., London, as their consulting engineer.

Walton.—A letter was read at the Urban District Council meeting from the Walton-on-Thames Electric Lighting and Power Company, Limited, forwarding, in accordance with the regulations, notice that it was the intention of the company to proceed with their application for a provisional order in the ensuing session of Parliament.

A New Electric Carriage.—A new electric carriage has just made its appearance, which is constructed on the "Ward" system. It has been completed to the order of Mr. William Marshall, of Tokenhouse-yard. It was travelling about London on Monday afternoon, running through the parks and visiting many of the West-end clubs.

Long Eaton.—At the meeting of the District Council the question as to what were the powers of the Council in regard to electric lighting was considered. The Deputy Clerk stated that he had looked over the minutes, and that as other notices would have to be given, no steps were taken. That was in 1889. It was decided the matter should stand over.

Appointments Vacant.—The Shoreditch Vestry require at the technical schools a competent man to act as assistant instructor to the electrical fitting class for one night per week at 5s. per night. Application, stating age and experience, to be sent to Mr. H. Mansfield Robinson, vestry clerk, Town Hall, Old street, E.C., by 27th inst., endorsed "Electric Fitter."

Yarmouth.—At the Town Council meeting the principle of electric tramways for the borough was agreed to, and the Lands Committee deputed to settle details, so that the promoters may apply for a provisional order within the statutory time. During October £188. 19s. 6d. was earned by the electric lighting department beyond the cost of producing the light.

Mountain Railways.—According to the *Revue de l'Electricité*, the recent storms have impeded the progress of the Jungfrau electric railway. On the same authority it would appear that Turin Chamber of Commerce is agitating a project for an electric railway from Aosta to Martigny over the Great St. Bernard. An English syndicate is said to be at the back of the enterprise.

Progress of Electric Lighting.—Tuesday night's *London Gazette* contains notices by the Denton, Epsom, Reigate, Hoylake and West Kirby, Bury St. Edmunds, Brighouse, and Watford Corporations and local authorities respectively of their intention to apply to the Board of Trade for provisional orders to supply electricity under the Electric Lighting Acts in their districts.

Cheltenham.—The electrical engineer has reported upon the best mode of supplying residents in Bayshill-villas (and subsequently in Royal-parade also). The cost of the preliminary works for supplying Bayshill-villas will be about £140. The Lighting Committee have resolved to add this amount to the £2,150, for which they have already resolved to apply for sanction to borrow.

Newmarket.—The Urban District Council have decided not to accept the offer of the gas company to share with the Council the expense of engaging an electrical engineer to report as to the suitability of the town for electric lighting. A public meeting has been held to protest against the action of the Urban District Council in resolving to apply for an electric light provisional order.

International Telescriptor Syndicate, Limited.—This Company has been registered, with a capital of £10,000 in £1 shares, to acquire the patents and inventions of B. Hoffman for all countries (other than Great Britain and the British colonies and dependencies) relating to telegraphic apparatus and to typewriting machines, and to carry on the business of a telephone and telegraph company.

Acton.—With the consent of the District Council Mr. Buxton deferred for a fortnight the proposition of which he had given notice with respect to electric lighting. It is reported that the Works Committee of the District Council have instructed the clerk to the Council to write to the secretary of one of the motor-car companies asking for an estimate of the cost of a scavenger's cart fitted with motors.

Liverpool.—A large section of Liverpool teamowners recently discussed the advisability of adding a new telephonic system to give increased facilities for carrying out promptly the heavy work which increasing trade brings to the port. As the result of the deliberations an executive committee was appointed to at once make the necessary arrangements, so that the new system shall be promptly put in working order.

Leigh (Lancs.).—The Urban District Council have appointed a committee to consider and report on the advisability of introducing a tramway system, and deciding whether the work would be better undertaken by the Council or by a company. A letter was read at the meeting on behalf of a company that proposed to obtain powers, stating that they only sought to do so in case the Council were not willing to undertake the risk of the project.

St. George's (Tower Hamlets).—At the meeting of the Vestry Mr. Pipe moved that the consent of the Vestry be given to the application to the Board of Trade of the County of London and Brush Provincial Electric Lighting Company, Limited, for a provisional order under the Electric Lighting Acts in respect of the St. George's East parish, the compulsory area being Cable street, Commercial-road, Cannon-street-road, and St. George-street.

Wellington (Somerset).—Under the title of Gent and Tomlyn a new firm is commencing business at the Champion Electrical Works, Wellington, as manufacturers of electric indicators, bells, and electric light and telephonic engineers. Mr. W. A. Gent, the first-named member of the firm, is the son of Mr. J. T. Gent, formerly of Gent and Co., Leicester, and Mr. Tomlyn is well known locally in connection with an old-established engineering firm.

Dudley.—The Public Works Committee reported at the Town Council meeting that Mr. Sellon, engineer to a company who are preparing to purchase the whole of the tramways in the South Staffordshire district, attended their meeting, and after much discussion it was arranged that Mr. Sellon should give further particulars on various points which were discussed, and that the whole matter should be further discussed at the next meeting of the committee.

York.—The Streets and Buildings Committee of the City Council have resolved that the letter from Messrs. Leeman, Wilkinson, and Badgerf, on behalf of a client, with proposals in regard to the transfer to him of the electric lighting order of the city, to be applied and worked by their client on terms mentioned, shall be considered in conjunction with the tenders to be invited for the installation under Prof. Kennedy's specifications, as agreed upon by the committee.

Hammersmith.—Rapid progress is being made with the electric light installation now being carried out by the Vestry, and in a short time the parish authorities will be prepared to supply current in the following thoroughfares: Hammersmith-road (between Broadway and St. Paul's Schools), Broadway, King-street (between Broadway and Ravenscourt-park), Brook Green road, Shepherd's Bush road, Shepherd's Bush green, Goldhawk-road to Starch-green pond, Uxbridge-road to Percy-road.

The Royal Train.—Several improvements in the Royal train used for the Queen's journeys to and from Scotland have been made at her Majesty's command by the London and North-Western Railway Company. Formerly the Royal carriages were illuminated by oil lanterns in their roofs. These, however, as well as her Majesty's reading lamps on the saloon table, have been replaced by electric incandescent lights, the current for which is supplied from a series of accumulators under the floor.

Maidstone.—We are informed that as soon as the preliminaries for acquiring a suitable site have been settled, a motorcar, carriage, and implement factory will be started in the town. The company will be in no way connected with any existing local works, and will not be associated in any way with any foreign syndicate; but will be of a purely English character, and principally under the directorship of landowners and gentlemen interested in the prosperity of Kentish agriculture and the hop trade.

Morley.—In bringing up the report on the electrical tenders at the Town Council meeting, which we publish under the head of "Results of Tenders," the chairman of the Lighting Committee congratulated the Council upon the fact that the total amount of the tenders—viz., £11,131, plus £750 for excavation work not included in the specification; a total of £11,881—was almost identical with the amount of the estimate laid before them some months ago by Mr. Hammond, the consulting engineer.

Rotherhithe.—At the meeting of the Vestry the General Purposes Committee recommended that the request of the County of London and Brush Provincial Electric Lighting Company, Limited, for the formal consent of the Vestry to their application for a provisional order for Rotherhithe be acceded to. The London Electric Supply Corporation, who already hold a provisional order entitling them to supply electricity to the parish, wrote objecting to a second company being allowed to come in. The matter was referred to committee.

Coseley.—At the meeting of the District Council Councillor Rolinson called attention to the syndicate which was being formed to take over first the steam trams and then those propelled by horses, the motive power to be taken from the nearest source. There were tramlines at Ettingshall and Princes End, and as it was probable that in future the trams would be driven by electricity, he thought the Council should be alive to the importance of the matter. It might be necessary that they should take the electric lighting into consideration again.

New Pocket Diary.—We have received from the *Mechanical World* offices a copy of the "Mechanical World Pocket Diary and Year-Book for 1897." We notice that a large amount of new matter of a thoroughly practical character has been introduced. Many new tables have been added, and sections included on such subjects as the testing of gas-engines, incrustation and corrosion in steam-boilers, notes on annealing, hardening, and tempering; the power required to drive machine tools, etc., which make the book of great value to the electrical and mechanical engineer.

West India and Panama Telegraph Company, Limited.—The report for the half-year ended June 30 states that the amount to

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credit of revenue is £42,317, against £39,849 for the corresponding half-year of 1895, and the expenses have been £22,280, against £21,848, leaving a balance of £20,037, which, with £1,325 brought from last account, makes a total of £21,362. The directors have placed £1,000 to reserve, and propose to pay a dividend on the ordinary shares of 1s. 6d. per share, tax free, leaving £1,968 to be carried forward. The traffic receipts show an increase of £2 695, while the expenses of repairing cables during the half-year amounted to £8,787.

Sale.—At the meeting of the Urban District Council the clerk (Mr. Halliwell) read the proceedings of the Joint Committee of the Ashton-on-Mersey and Sale Councils on the subject of the proposed line of tramway from Stretford to Peel Causeway along the Manchester highway, to be laid by the Manchester Carriage and Tramways Company and the syndicate who proposed to work the same length of tramways by electricity. The committee, after careful consultation so far as it affected their districts, unanimously recommended that the Ashton and Sale Councils take the feelings of the ratepayers by a poll as to the desirability or otherwise of adopting any tramway scheme. The minutes were received.

The Brussels Exhibition, 1897.—A meeting of the British Commission for the Brussels International Exhibition of 1897 was held this week at the London Chamber of Commerce, Sir Albert K. Rollit, M.P. (president), in the chair. The President said that the space they had originally taken—30,000 square feet—was insufficient, but they now had, as a result of negotiations, the opportunity of taking an additional 30,000ft. at a reduced rate. After discussion the Commission unanimously resolved to authorise the taking of the proposed additional space and to increase the guarantee fund. It was announced by the president at the conclusion of the meeting that the total amount guaranteed was nearly £5,000.

Mathematical Instruments.—We have received from W. J. Stanley, Great-turnstile, Holborn, W.C., his "C" catalogue of mathematical, drawing, and surveying instruments. The catalogue is a very full one—Fuller's slide, for instance, is quoted—and besides instruments proper there are sections for photographic, electrical, and "optical" work, as well as the particular kind of stationery affected by the student and engineer. A new feature is a very complete telegraph code for ordering. This is a new feature in Mr. Stanley's catalogue, and from a business point of view is not a bad idea, since it encourages the engineer or surveyor to carry the catalogue about with him, so that if he finds he wants anything he can get it at once.

Sheffield.—At the meeting of the City Council Mr. Harry Fisher asked the chairman of the Tramways Committee a question with reference to the acquisition of various plots of land for power stations. It was, he said, several weeks since the electrical expert returned, and though they had not yet heard what recommendations they had made, it would appear, as they were securing land for power stations, that they had come to some decision Alderman Clegg said the only object in asking for power to acquire these lands was that the Council could comply with the statutory requirements. If the committee did not decide in favour of electricity, then they would have committed themselves to nothing and need not proceed further.

Hastings.—At the Town Council meeting the Public Lighting Committee submitted the following communication from the Board of Trade: "Hastings (Public Purposes) Electric Lighting Order, 1890.—With reference to previous correspondence on the subject of the above-mentioned order, I am directed by the Board of Trade to inform you that they approve of the system, of which a description is annexed hereto, for the supply of electrical energy for the purpose of the order, subject to the regulations for securing the safety of the public (a copy of which is also annexed), which are hereby imposed upon the undertakers, under the above-mentioned order by the Board of Trade." It was resolved that the communication should be entered on the minutes.

Aberdeen.—The mason's work of the extension of the electric lighting station in Cotton-street has just been completed by Mr. Robert Smith, builder. Kemnay granite has been used in the front, and the features are a picked panel above the central doorway, and rustic masonry all along the front between two dressed bands; the quoins are also rusticated, the remainder being puncheoned ashlar. On the top, in the centre of the building, is a conspicuous architectural feature in the form of a dressed pediment or tympany, 17ft. long and 12ft. high, with ball ornament for finish, projecting boss, and large well-cut rams'-horn scroll ornamentation. The date "1893" appears in raised figures, 20in. in length. A lofty chimney shaft in brickwork is also nearly completed.

Mold.—At the meeting of the Urban Council it was reported that a special meeting of the Council was held on the 14th ultimo to confer with Mr. Fawcus, engineer, of Manchester, regarding a proposal to construct a light railway between Mold and Holywell, *viâ* Halkyn. At that meeting Mr. Fawcus said the railway might be worked by electricity, but before going into the matter further he would like to know if he had the support of the various local authorities through whose districts the line would pass, and whose ratable value would be increased. At the special meeting the members declared themselves in sympathy with the proposal, and recommended its further consideration. Several members now supported the project most heartily, and a resolution declaring sympathy with it was carried.

Hampstead.—At the meeting of the Vestry the Lighting Committee recommended that High street, Hampstead, Rosslyn-hill, and Haverstock-hill, as far as the boundary of the St. Pancras parish, be lighted with electric arc lamps. The recommendation was adopted. Mains for the supply of electric current to private consumers are to be laid in the following roads: Ebbsfleet-road, at an estimated cost of £58; Steele's-road, £63; Hilgrove-road and part of Adelaide-road, feeder and distributor extension to Avenue-road, £210 The number of electric lighting consumers at Michaelmas was 485, as compared with 212 at the corresponding date last year. The revenue for the quarter ended at Michaelmas was £1,595. 1s. 4d., as compared with £754. 10s. 10d. for the corresponding period last year.

Accident at an Electric Lighting Station.—A report was current on Saturday night as to a serious accident having occurred at the works of the St. James's and Pall Mall Electric Lighting Company, resulting in injury to six men, four of whom had been carried to the hospital. On enquiry, however, a Press representative was informed that the accident, which happened at the Mason's yard station of the company, was but a slight one. Some men belonging to a firm of engineers were repairing electric lighting machinery, when a pulley rope holding a cylinder broke, and the metal in falling was shattered. Two of the workmen were injured by being struck by pieces of the cylinder, but only one at all seriously. He was hit with such force as to cause a fracture of a bone in the left leg.

The British Electric Traction Company.—This Company has been registered, with a share capital of £600,000 divided into 30,000 6 per cent. cumulative preference and 30,000 ordinary shares of £10 each, and the issue of £300,000, in 30,000 ordinary shares of £10 each at par, is now advertised in this paper. The Company is formed under the auspices of the Electric and General Investment Company (on lines similar to those of the City of London Electric Lighting Company), to acquire the business of the British Electric Traction (Pioneer) Company which has a subscribed share capital of £50,000, and was established to develop electric traction in the United Kingdom and elsewhere, with a view to the formation in due course of the present Company. The list of subscriptions closes to-day (Friday) for both town and country.

Edinburgh.—At a meeting of the Royal Infirmary managers, Dr. Claude Muirhead gave in the report of a committee as to the appointment of an honorary medical electrician to the infirmary. It stated that the committee had approached Dr. Milne Murray, who had consented to give what time he could spare to aid the managers in the installation of electricity for medical purposes and to give his advice in the starting of the electrical department. The committee, therefore, recommended that the managers appoint Dr. Murray as honorary medical electrician to the infirmary. The report went on to say that as Dr. Murray could not give the necessary time for the full working of the new department, the committee recommended that the managers appoint Dr. Dawson Turner to be honorary assistant medical electrician to the infirmary. The report was approved of.

Kingston-on-Thames.—Councillor Collings, chairman of the Lighting Committee, stated at the Town Council meeting that during the last nine months the working expenses had amounted to £1,926, and the receipts were £1 866, showing a loss on the nine months' working of £60. But from a careful computation he believed he could safely predict that by the close of the year the receipts would show an excess over expenditure of about £11. Within the last few months successful experiments had been made with a system of lighting street lamps in series with incandescent lamps turned on and off from the works. He mentioned that a scheme was now under consideration by which householders could have their houses wired free of cost, the proprietors of the electric works paying the company who did the wiring a certain percentage on their outlay.

Chester.—The new electric light works in Crane-street are fast nearing completion. The chimney shaft has been erected, and its height is 140ft. In the boiler-house there are three boilers, fixed up by Messrs. Babcock and Wilcox. The whole of the ironwork, the roofing and the columns, are of extra strength, and have been manufactured and fixed by Messrs. Smith and Sons, Whitchurch. In conjunction with the boilers there is a range of Green's economisers. In the engine-house there will be three engines of 130 h.p. There are 230 accumulators. The sole contractors of the works are Messrs. Parker (Wolverhampton), and the whole of the buildings and chimney have been entrusted to Mr. Thomas Browne, contractor and builder, Chester, the erection of the machinery and buildings being under the supervision of Prof. Kennedy and Messrs. John Davies and Sons, architects, Newgate-street.

London.—At the meeting of the Commissioners of Sewers the Finance and Improvement Committee recommended that a fee of 10s. should be fixed for the testing of consumers' wires and fittings under the provisions of the regulations made by the Board of Trade under the Electric Lighting Acts and Orders, and that notice of the intention of the Commissioners to prescribe such fees be duly advertised. Mr. Voysey, in answer to Mr. Barham, said the meters registering the current of the electric light were not always correct. The meters varied from 30 per cent. fast to more than 20 per cent. slow, but on the whole he believed the electric current was fairly registered. Indeed, the balance was in favour of the consumer. The report of the committee was adopted. The electrical engineer (Mr. Voysey), in answer to Mr. Gordon, said he intended reporting upon several failures of the public and private supply of the electric light.

Penarth.—Application will be made to Parliament this session for an Act empowering the construction of an electric tramway between Cardiff and Penarth. We understand that the owners of the road—the trustees of the Bute estates and the representatives of Lord Windsor—look upon the scheme with favour; and settle-

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ment of the question of purchasing the road by the local authorities is expected to form part of the scheme. It is further intended to apply for a provisional order to supply the electric light to Penarth from the generating station which the promoters of the tramway scheme will establish at that end. It is understood that the difficulty which has barred the negotiations between the owners of the road and the local authorities—namely, the desire of the former to retain power to make railway crossings on the level—will be obviated. The electric tramway will at its Cardiff end have two branches—one terminating in St. Mary-street and the other near James-street Bridge, the route to the latter being from Penarth-road, along the Corporation-road, and over Clarence Bridge. A 10-minute service of cars is projected.

The Mumbles Railway.—The *Cambrian* says it has reliable authority for stating that the second offer of the electrical syndicate to purchase the Swansea and Mumbles Railway, with a view of working it by electricity, has been definitely refused. Two members of the syndicate, which includes several very wealthy and influential commercial men, visited Swansea the week before last and made an inspection of the railway and its immediate surroundings. A few days afterwards, Sir John Jones Jenkins, M.P., as chairman of the Mumbles Railway Company, received a letter making an improved offer for the purchase of the line. The directors, after some consideration, decided to refuse it because sufficient was not offered for the goodwill of the undertaking. This does not mean that all negotiations have fallen through between the syndicate and the railway company. It is probable that they will be resumed at an early date, but whether the terms will come up to the demands of Sir John Jones Jenkins and his co-directors remains to be seen. It is stated that another electrical syndicate is making overtures for the purchase of the railway.

Kingston-on-Thames.—At the meeting of the Surrey County Council the Highways and Bridges Committee reported that they had received a communication from the Motorcar Club asking for permission to run motorcars over a portion of the main roads of the county on the occasion of the proposed running of motorcars from London to Brighton on the 14th inst., but as it was quite impossible that the cars should be run in accordance with the existing Highways Acts and the by-laws of the Council, the committee could not of their own motion nor recommend the Council to grant such permission. Mr. E. Ellis moved the adoption of the report, and said that a great objection to the motorcar was the question of speed. The recent Act allowed them to be propelled at the rate of 14 miles an hour, which the committee thought was excessive, and they had written to the Local Government Board to that effect. They also suggested that, having regard to the narrowness and crookedness of some of the highways in Surrey, that the width of the cars, which might be 7½ft., was too great, and that 6ft. should be the maximum width. Some of the roads in Surrey were only 6ft. wide. They further suggested that the person in charge should be duly licensed. The report was adopted.

Accumulator for Motorcarts.—The Sola-Headland accumulator has been described in the *Daily News*, having been demonstrated to a representative of that paper apparently by no less a person than Mr. Spagnoletti himself. The invention is yet one more new form of grid. "The plates are made up of leaden bars, into which the active material is pressed, and, from the construction of these bars, it becomes practically impossible for the paste to drop out. Equal surfaces being exposed on four sides to the action of the current, buckling of the plates is avoided, even on the severest test of short-circuiting the cells. This feature renders it unnecessary to employ the large amount of lead hitherto required to give the older form of plates the strength necessary to stand the heavy strain of traction work. The cells thus equipped, presenting the largest possible surface of active material to the action of the current, are consequently much smaller for a given capacity than any other on the market, and a saving in weight of over 50 per cent. has been effected." If all this is sustained, the battery ought to do for motorcart work, and as a matter of fact the London Electric Omnibus Company have fitted their electric cart, which will take the road on Saturday next, with it.

Stroud (Gloucester).—Messrs. Marling and Co., Limited, have recently had an electric light installation put down at their Ebley Mills. The generating plant consists of a "Tyne" compound-wound continuous-current dynamo, having an output of 175 amperes at 105 volts when running at a speed of 950 revolutions per minute, and is capable of feeding 350 incandescent lamps of 16 c.p. each. The motive power is derived from a 35-h.p. vertical high-speed engine, fitted with two heavy flywheels and crankshaft governor, to ensure steady running, and is transmitted to the dynamo by an 8in. Leviathan belt. Throughout the mill there have been fixed 350 lights attached to brackets and flexible pendants, each being provided with an enamelled iron reflector and controlled by a separate switch, or arranged in groups as has been found most convenient. The whole 350 lights are further controlled from a main switchboard in the engine-room, on which are fitted a main double-pole quick-break switch and fusible cut-outs and a voltmeter and ammeter. The work has been carried out by Messrs. Ernest Scott and Mountain, Limited, Close Works, Newcastle-on-Tyne, who are the manufacturers of the machinery, under the supervision of their local representatives, Messrs. Macdonald and Golledge, St. Aldate-street, Gloucester.

Southampton.—The Corporation, with the assistance of Mr. J. H. Lee, borough electrical engineer, are making preparations for erecting a lighting station of the most modern type in which the existing machinery purchased from the Southampton Electric Light and Power Company will be placed. The Electric Lighting Committee recommended at the Town Council meeting that the engineer be empowered to purchase an additional donkey engine, at an estimated cost of £12. 10s. Mr. Manville (consulting engineer) reported that there was no reason why the main with the present plant should not be extended to the end of Oxford-street and East-street. The committee recommended the Council, as soon as the consulting engineer was prepared with the necessary drawings, specifications, etc., to advertise for tenders for extending the mains for which sanction had been received, and that the extension of the main to Oxford-street and East-street (eastern end) be carried out at an early date. It was also resolved that after March quarter the maximum price for the supply of electric light be reduced from 7d. to 6d. per unit, and that the present charge of 6d. per unit for motive power to the Harbour Board and other consumers be reduced to 3d. per unit, such reduction to take effect at and after the Christmas quarter. The report was adopted.

Limehouse.—At the meeting of the District Board of Works the question of the provisional order being granted to the British Electric Lighting Company was discussed. Mr. Brennan asked the terms of agreement with reference to purchase price to be paid in the event of the local authority desiring to take the lighting into their own hands, and having elicited that 33 per cent. premium would have to be paid to the company for the purchase of the mains, etc., of the company as laid down in the district, he objected to the whole thing as an endeavour to create a monopoly. Mr. Warren moved that the whole matter be referred back for an exhaustive report. Mr. Hartnoll said that the question of monopoly seemed to him to exist rather in the gas company than in the suggested provisional order being granted. Of course, there were vested interests, but if they did away with the coal-whipper they put the electrician in his stead. The Clerk, in reply to questions, said that the granting of the order would not in any way prejudice the Board in making an application to the Board of Trade for permission to lay down their own installation. Mr. Knight could not consent to giving what belonged to the people to any company. It seemed to him monstrous for any corporation to ask for a margin of 33 per cent. on their outlay. It would be wisest to refer the matter back to committee. He should delight in the establishment of electric lighting in the district. It was agreed to sanction the recommendation of the committee.

"Electric Locomotives."—By favour of the Westinghouse Electric Company, Limited, 32, Victoria-street, S.W., we have received what is called a pamphlet (it has stiff covers and runs to 123 pages) by Mr. D L. Barnes on "Electric Locomotives." The book is really a catalogue of the various makes of the Westinghouse-Baldwin locomotives. The number of standard types of these already in manufacture in America will probably be a surprise to the outsider. They, of course, are most of them street railway—*i.e.*, tramway—types, but there are some others. All are really electric locomotives, not like the Heilmann engine—a steam locomotive with an electrical speed gear. So much for the subject of the book. In other respects it is an example of the way in which the Americans do not spare expensive illustrations, excellent paper, and sumptuous print in turning out a work of this class. A now forgotten writer, De Morgan, once advocated the adoption of brown printing ink. If anyone wants to see the result, the present catalogue may be taken as the best that can be done in that way. There are abundant illustrations (not in brown), including one of the mining locomotive that was a short time ago described in a note in this paper, and a quantity of efficiency curves for various types of motors and 11 examples of how to use them. The illustrations, as we have remarked before, are excellent. The letter-press is obviously designed for popular consumption, and not for the electrical engineer. All the same, the glossary of electrical terms at the end should either have been better done or omitted altogether. The description of magnetic saturation, if not absolutely incorrect, is certainly likely to give a wrong impression to anyone who did not already know something about it, while to the same sort of person the definition of "polyphase" would probably convey no idea at all. The irritating practice of calling a stationary transformer a "converter" is probably merely an American peculiarity.

Rathmines.—The proposed tramway from Rathmines to Ball's Bridge was discussed at the meeting of the Commissioners. The Chairman took the opportunity of referring to the letter of Mr. William Murphy which had appeared in the papers on behalf of the tramway company. He (the chairman) was prohibited owing to a resolution he long since arrived at of not replying in the newspapers. He desired to say that no member of that Board was actuated by any feeling of hostility towards the tramway company, and if the Commissioners constructed the proposed line to Ball's Bridge it would be with the intention of leasing it or hiring it out, as it were, to those who gave them the best terms. All the directors of the tramway company were personal friends of his, and it would be his last thought to do anything that he could avoid to harass them. Of course, it was the duty of every commissioner of the township, as such commissioner, to serve the interests of Rathmines, and it was with that object the Board were promoting this Bill. A meeting of the ratepayers of the township would be held, and a full statement would be made on behalf of the Commissioners at that meeting. Mr. Bolton said Mr. William Murphy had referred to him in the letter, stating that he was wrong in what he had stated as regards electric traction in Glasgow. The statements he had made were taken from a report of Mr. Hopkins, and were in black and white. Mr. Carey said Mr. Murphy's letter pointed to a compromise and arrangement between the tram company and the township, and for his part he would be quite prepared to agree to that. They had no complaint against the company, which was working for the

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benefit of the people at large. The Commissioners wanted to come to fair terms. With regard to Mr. Murphy's objection that the tramway company was prohibited from selling by the Tramways Act of 1878, he wished to refer Mr. Murphy to the twenty-eighth section of that Act, which clearly showed that the prohibition was to a voluntary sale by the company and did not apply to a compulsory purchase.

Branksome.—The General Works Committee reported at the Urban District Council meeting that they had had before them an application from the Bournemouth and District Electric Supply Company asking the Council to sanction their coming into the district, and the committee recommended the Council to approve of the order subject to a condition being inserted requiring the company to give notice before disturbing the roads, and some guarantee that the ground should be reinstated to the satisfaction of the surveyor. Mr. Brown thought the Council should give every facility for the installation of the electric light in the district and encourage the company. The Clerk said that in addition to adopting the recommendation of the committee they should pass a special resolution on the subject. The company had deposited a copy of the provisional order, which the committee had had before them. The electric company wanted power over the whole of the Branksome district. The Chairman said it was very expedient that no obstacle should be thrown in the way of the company coming into the district as soon as they could. The resolution suggested by the clerk seemed to meet all points very well, and was equitable to all parties. Mr. Gulliver proposed and Mr. Arnold seconded the following resolution: "That the consent of the Branksome Urban District Council be and the same is hereby given to the grant of a provisional order under the Electric Lighting Acts, 1882 and 1888, to the Bournemouth and District Electric Supply Company, Limited, in respect of the urban district of Branksome, subject to a clause being inserted in such provisional order that before commencing any repairs, renewals, inspection, or amendments of their existing works which will involve the breaking up of the surface of any street or road repairable by any local authority, the undertakers shall serve a notice thereof upon the local authority, and immediately after the completion of the works the undertakers shall repair, reinstate, and make good the street or road to the satisfaction of the surveyor of the local authority, and in default of the same being so repaired, reinstated, and made good within seven days after the surface of the street or road is so broken up, the local authority may themselves repair, reinstate, and make good such street or road, and recover summarily from the undertakers the costs thereof." The resolution was carried.

Telephone Delays.—Complaints of delay and indistinctness of communication on the part of London subscribers to the telephone system using the trunk lines to the North have induced a representative of the *Daily Telegraph* to make some enquiries at the General Post Office, and at the headquarters of the National Telephone Company, in Orchard-court, Cannon-street. At the Post Office the officials in charge of the Government trunk telephone lines to the North, while admitting that complaints of delay had been received by them, said no reference to indistinctness was made in connection with the lines to Glasgow. That city was now connected with London by a specially-constructed trunk line, which included all the latest improvements in long-distance telephony. Its only fault was that it was unable to accommodate the vast amount of work required of it between eleven o'clock and four in the daytime. The only remedy which the officials could suggest was an increase in the number of telephone lines to Glasgow. In the last session of Parliament a sum of £300,000 had been voted to improve telephonic communication, and this money was being expended as rapidly as possible for that purpose. The manager of the National Telephone Company, on being interviewed, admitted that the wires to the North had been faulty for some days, but he could not explain the defect, as it occurred on the Government lines It might be due to atmospheric causes, or be occasioned by the linesmen in the course of their work. Questioned with reference to the particular case of Glasgow, the manager said in that city the old single-wire system was still largely used, and some of the faults complained of might be due to it. The company, however, were ready to put up metallic circuits at any time, but the Corporation of Glasgow refused the necessary wayleaves, and the old system had to continue. He would admit at once that the single-wire circuit was unsuitable for long-distance telephony and the operators for the company had instructions not to "switch on" subscribers using it to the long-distance trunk lines. In London the company had spent a quarter of a million in establishing metallic circuits and supplying Deckert transmitters. If a similar course could be adopted in Glasgow, he believed most of the inconveniences now experienced would disappear. With regard to local telephony in London itself, he thought there was little to complain of.

Manchester.—We understand that the Manchester City Council intend making an experiment with arc lamps for street-lighting. No extensive scheme is contemplated at present, however, it only being intended to erect a few arcs in prominent positions to judge of their effect. It indeed seems to us surprising that arc lighting has not been adopted long since in a city of such importance as the "cotton metropolis," having regard to the successful lead taken by other towns. The lack of enterprise shown in this direction in Manchester becomes all the more apparent when the wonderful success which has marked the undertaking of the Corporation's supply of electrical energy to private consumers is taken into consideration. It may be that the rapid increase in the output from the Corporation electricity works to private consumers since Mr. C. H Wordingham was appointed to the post of chief engineer has detracted attention from public lighting by taxing to the utmost the energies of those in charge to cope successfully with the demands of private consumers. Now even that extensive additions have just been made to the plant—making Manchester second only in point of total output to the City of London station—it is probable that these latest additions, consisting of four 400-h.p. sets of engines and dynamos, will, together with the original plant, be fully loaded in the near future. Having regard to this fact, it of course becomes obvious that further extensions of plant would be necessary should an extensive scheme of street arc lighting be adopted, and this would also necessitate the extension of the generating station buildings, the present floor space being wholly taken up, Although there is at present no public arc lighting, it may be interesting to observe that close on 1,000 arc lamps have been fixed by private consumers, mostly for shoplighting. The maximum output of the station yet reached has been 5,800 amperes at 400 volts, so that when this output was generated the number of lamps in use must have been equivalent to about 70,000 of 8 c.p. These figures will give a rough idea of the popularity of the electric light in Manchester. While on this topic, we may add that the appointment of Mr. Gilbert Bell, lately assistant engineer at the Manchester station, to the post of resident engineer at Hammersmith caused slight changes to be made in the organisation of the staff at Manchester; but virtually Mr. P. J. Watts, who was chief at Whitehaven, has been appointed to fill the vacancy.

Shoreditch.—At the meeting of the Vestry, Mr. Wells introduced a further report stating that the vestry clerk had informed the Finance Committee that it would be necessary to take up a loan for electric mains, conduits, and drawing-in boxes made up as follows: contract sum, £15,705; engineer's commission, 3 per cent., £471; clerk of works' salary, £102; contingencies and extras, £722—total, £17,000. The Finance Committee advised, and their recommendation was adopted, that the vestry clerk be instructed to make immediate application to the London County Council for their sanction to a loan for £17,000, at 2¾ per cent., for a mean period of 42 years, on the annuity principle, and that the Council be requested to advance the money. At the meeting of the same Vestry Mr. Kershaw introduced a report of the Electric Lighting Committee, stating that they had carefully considered a letter from the Electric Free Wiring Syndicate asking that the Vestry would enter into a contract with them placing them in a position to inform would-be consumers of electricity that they could have their premises fitted up for electric light and power purposes without any initial charge, the stipulation being that the consumer so wired should pay ½d. per unit more for the energy supplied to him than would be paid by a consumer who paid cash for his wiring, and that as the Vestry received payment so the ½d. per unit would be sent to the syndicate. The committee had informed the syndicate that they had approved the scheme in the abstract, subject to further consideration of the terms as to the purchase of fittings by the Vestry after three years. They had accordingly instructed the vestry clerk to draw up an agreement, which is to include, among others, a clause giving the Vestry the option of purchasing at any time after three years, or any consumer after five on terms to be settled in detail; the wiring to be done to the satisfaction of the Vestry's engineers, and the contract not to be exclusive of other firms of free wirers. The Vestry gave their adhesion to the scheme The Electric Lighting Committee reported that they had decided to build the sub-station under the site of the refuge in Curtain-road, opposite Messrs. Law Bros.' premises in preference to the site under the refuge in Great Eastern-street, the former site being more out of the way of traffic and tramway lines. On the motion of Mr. Kershaw the action of the committee was approved; and on his proposition the tender of Messrs. Atherton and Dolman to carry out the work of erecting the sub-station was adopted, the amount being £893. This was the only tender sent in, the estimate of the Vestry's electrical engineers being £850. The Bethnal Green Guardians have asked the Vestry for a price for supplying the workhouse and the Guardians' offices with electricity.

Salford.—The Corporation electricity works at Salford, opened some 14 months ago, have been making gradual progress in spite of odds peculiar to the district. We understand that the Pendleton Co-operative Society are just opening a new branch establishment in Broughton wired for an equivalent of 712 8-c.p. lamps, connection being made to the Salford Corporation mains. A 3-h.p. motor has also been installed. This addition to the number of lamps connected will bring up the maximum output at the electricity works to about 125 kilowatts. The station started with 20 consumers, while there are now 60 connected, with a total of 11,000 lights installed. This total of lights installed will be noticed to be altogether disproportionate with the number of consumers which they are divided amongst, the average per consumer working out at about 184. We believe that the probable high average of lamps per consumer connected, owing to the peculiarities of the districts through which the mains extend, was a weighty consideration with the designer of the present station at Salford. There is no "day-load plant" in the popular sense of the term, one of the three units installed—namely, a 120-kilowatt Mather and Platt alternator—having to be run continuously to take the usual small day load. When it is considered that the usual day load at such a station would probably be not more than 10 amperes, a portion of this being merely exciting current for the transformers, it would appear at first sight a great fault in the design not to have a day-load plant. But in this particular instance, where the district of supply is very scattered, and the runs of main extremely long, a local fog

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is likely to come over any portion of the network of mains unknown to those in charge at the station. In such an eventuality there are consumers who might switch on a great number of lights at a moment's notice, hence the necessity of always running a large generator to the exclusion of a "day-load plant" proper. Another peculiarity of the Salford station is that the generation of current is at 3,000 volts pressure, which is transformed down in sub-stations, and in some few cases in the houses. Notwithstanding this, however, the station has hitherto been run without a failure or hitch in the supply of any kind, which fact reflects great credit on both the designer and those in charge. A recent survey of the district convinced us that there is a great prospect for the Corporation's electric light undertaking providing that more advantageous terms can be offered to large consumers for the supply of current. The present supply is at 6d. per Board of Trade unit, we believe, without any differential rates of discount to large consumers. This is certainly a mistake which the Electric Light Committee would do well to rectify. There are at present several large prospective consumers negotiating with the authorities for a supply of current, and in the event of satisfactory arrangements being concluded with same it is a question whether extensions to the plant at the station would not have to be immediately considered, as, in accordance with the principle of always holding one unit of plant in reserve, the present capacity of the station is only equal to 10 000-8 c.p. lamps. From further enquiries which we made in the district, we are of the opinion that could the price per B. T. unit supply to large consumers be fixed at from 2d. to 4d., then an enormous increase in the number of lamps connected would result. There seems not much tendency, however, among millowners to adopt the separate motor system of running their machinery; this will come with a reduction of price per unit, but, on the other hand, there is a decided tendency to adopt electric lighting on favourable terms. Salford is altogether a peculiar district to supply, but we must confess we should like to see a differential rate in favour of large consumers adopted.

PROVISIONAL PATENTS, 1896.

NOVEMBER 2.

24381. Improvements in electric switches. Morton Blencowe Cotterell and Hubert Russell, 13, Lanier road, Lewisham, London.

24413. An improved handfeed electric arc lamp. Alexander George Smith, 23, St Nicholas street, Aberdeen.

24456. Improved method of generating alternating currents. David Cook, 30, Lancaster-park, Richmond, Surrey.

24472. Improvements in and connected with frames for electric accumulators. Henry Leitner, 37, Chancery-lane, London.

24473. Improvements in and connected with primary and secondary galvanic elements. Henry Leitner, 37, Chancery-lane, London.

24475. Improvements in and relating to plate carriers for secondary batteries. Henry Leitner, 37, Chancery-lane, London.

24481. Improvements in casings for electric conductors. Henry Reason, Norfolk House, Norfolk street, Strand, London.

NOVEMBER 3.

24548. An improved automatic safety device for electric circuits Lewis G Rowand, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

24551. Improvements in electric railways. Harry Clifton Reagan, jun., 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

24554. An improved way of connecting electrical fittings. Reginald Callaway Jeboult, 5, Rosemont-road, Finchley-road, London.

24577. Improvements in the preparation of filaments for electric lamps. John Hadden Douglas-Willan, 24, Southampton-buildings, Chancery-lane, London.

24594. Improvements in electrical resistance devices. George King Cummings, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

NOVEMBER 4.

24685. An electric arc lamp or regulator for magic lanterns, search-lights, or theatrical purposes. Jacob Bonn, 1, Holborn-place, London.

NOVEMBER 5.

24766. New and improved switches for electric currents. William Robert Rawlings and John Joseph Rawlings, 82, Gloucester-road, South Kensington, London.

24783. Improvements in connection with submarine cables for forming electric communications between lightships and the shore; also applicable for other purposes. James George Browne, 47, Lincoln's-inn-fields, London.

NOVEMBER 6.

24897. An improved pneumatic-electric relay for organ mechanism. Gotthilf Friedrich Weigle, 6, Bream's-buildings, Chancery-lane, London.

24924. Improvements in electrically operated cloth-cutters. George Peter Eastman, 4, South-street, Finsbury, London.

24910. Improvements in brushes for dynamo-electric machines. Pierre Joseph Charles Carron, 45, Southampton-buildings, Chancery-lane, London.

NOVEMBER 7.

24947. Improvements in and connected with electric arc lamps. Albert Lewis Davis, 68, Victoria-street, Westminster, London.

25001. Improvements in electric lighting apparatus for cabs and other carriages. Headland's Patent Electric Storage Battery Company, Limited, and Henry William Headland, 77, Chancery-lane London. (Complete specification.)

25030. Improvements relating to the regulation of electricity meters. Reginald Page Wilson, 70, Chancery-lane, London.

25036. Improvements in or connected with electric batteries. John Laskey Dobell, 57, Chancery-lane, London

SPECIFICATIONS PUBLISHED.

1895.

15215. Telegraphic printing apparatus. Buckingham

19832. Electric propulsion. New and Mayne.

22060. Automatic telephone exchange systems. Lounsbury.

23922. Means for compensating variations of load at electrical stations. Siemens Bros. and Co., Limited. (Siemens and Halske.)

23943. Lighting of streets and the like by incandescent electric lamps. Quin and Reason.

24020. Safety fuse devices for electrical installations. Siemens Bros. and Co., Limited. (Siemens and Halske.)

24049. Electrical contacts for burglar and like alarms. Moulart and de Galard.

24577. Movable supports for movable flexible electric conductors Laurie.

1896.

18549. Electrical primary batteries. Whittemore.

18593. The cores of dynamo-electric machines and other electrical apparatus. Kelly.

18652. Conductors and switches for electric railways. Lake. (Lundell.)

19456. Electric traction system. Thompson and Walker.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	8¾-9¼
Brush Company, Ordinary	3	¾-1¼
—— Non. Cum., 6 per cent. Pref.	2	1-1¼
—— 4½ per cent. Debenture Stock	100	110-113
Central London Railway, Ordinary	10	10-10½
——	2	4-4½
Charing Cross and Strand	5	9½-10
Chelsea Electricity Company	5	7¾-8¼
—— 4½ per cent. Debentures	100	114-117
City of London, Ordinary	10	16-17
—— 6 per cent. Cumulative Pref.	10	17-18
—— 5 per cent. Debenture Stock	100	130-135
City and South London Railway, Consolidated Ordinary	100	50-52
—— 4 per cent. Debenture Stock	100	135-137
—— 5 per cent. Pref. Shares	10	15-15½
County of London and Brush Provincial Co., Ordinary	10	8½-9½
—— 6 per cent. Cum. Pref.	10	13¾-14¼
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
Edison and Swan United Ordinary	3	1¾-2¼
—— 4½ per cent. Debentures	100	103-106
Electric Construction, Limited	2	1¼-1¾
—— 7 per cent. Cumulative Pref.	2	2½-3
Elmore's Copper Depositing	2	½-¾
Elmore's Wire Company	2	½-¾
W. T. Henley's Telegraph Works, Ordinary	10	17-18
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	109-114
House-to-House Company, Ordinary	5	3¾-4¼
—— 7 per cent. Preference	5	8¾-9¼
India Rubber and Gutta Percha Works	10	21-22
—— 4½ per cent. Debentures	100	105-108
Kensington and Knightsbridge Ordinary	5	9½-10
—— 6 per cent. Pref.	5	8½-8¾
Liverpool Electric Supply, Ordinary	5	8-8½
Liverpool Overhead Railway	10	13¼-13¾
—— 5 per cent. Pref.	10	17¼-17¾
—— 4 per cent. Mortgage Debentures of £100	100	112½-114½
London Electric Supply	5	¾-1¼
Metropolitan Electric Supply	10	13-14
—— 4½ per cent. First Mortgage Debenture Stock	100	121-124
National Telephone, Ordinary	5	7¼-7⅝
—— 6 per cent. Cum. First Pref.	10	17-19
—— 6 per cent. Cum. Second Pref.	10	17-19
—— 5 per cent. Non. Cum. Third Pref.	5	6½-7
—— 3½ per cent. Deb. Stock	100	105-108
Notting Hill Company	10	10½-11½
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8½-9
—— £4½ shares	4½	7½-8
Oriental Telephone and Electric Company	1	¼-⅜
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	103-106
Southampton Electric Company	5	4¾-5¼
St. James's and Pall Mall, Ordinary	5	12-13
—— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	39-42
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	—	7¾-8¼
Westminster Electric Supply, Ordinary	5	10½-11½
Yorkshire House-to-House		7½-8

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NOTES.

The Pacific Cable Scheme.—The conference has taken the evidence of Mr. Sandford Fleming.

Institution of Electrical Engineers.—The annual dinner of the Institution takes place next Wednesday (November 25) at the Criterion Restaurant, Piccadilly, at 7 for 7.30. At Thursday's meeting Mr. Gavey's paper on "Trunk Telephones" is to be discussed.

Water Power for St. Petersburg.—It is stated that the intention of utilising the Imatra Falls in Finland for the electric lighting of St. Petersburg has been abandoned. The scheme which now finds favour is to get the requisite water power from the neighbourhood of Narva.

Electric Furnace Work.—In the *Annales de Chimie et de Physique* Mr. Moissan gives an account of his preparation of titanium, molybdenum, uranium, manganese, and the borides of iron and of carbon by means of the electric furnace. There is little, however, of interest which has not been given from time to time as the work was done.

Mr. Crookes on Kimberley.—Lord Loch presided at the Imperial Institute on Monday, when Prof. W. Crookes, F.R.S., delivered the first of a series of lectures on "The Diamond Mines of Kimberley." At present the lectures are all about the mines. It is possible Mr. Crookes may have something to tell us about diamonds by-and-by.

In and Out.—According to *L'Electricien*, in the first six months of the present year the Austro-Hungarian Empire imported 148 dynamos and exported 117. Of the imported machines, 104 came from Germany, 31 from Switzerland, and nine from England. Of the exported machines, 30 came to England, 24 went to Russia, and 14 each to Italy and Germany.

Institute of Chemistry.—The next examinations for the membership of this institute will be held on Tuesday, January 12, 1897. In consequence of the increase in the number of candidates whose applications for examination have been accepted by the council, it is probable that more than the two ordinary examinations (January and July) may be held in the forthcoming year.

Glasgow Physical Society.—The first meeting of the Physical Society of Glasgow University for the session takes place to-day (Friday), when the presidential address will be delivered by Dr. Magnus Maclean on the subject of the Röntgen rays. Communications have been promised by Dr. J. C. Beattie, Dr. J. T. Bottomley, Mr. Alexander Galt, Prof. George A. Gibson, Mr. John Gray, Mr. J. R. Erskine Murray, and Dr. M. Smoluchowski Smolan (Vienna).

The "Synthetic Philosophy."—It may be worth a line to note that Mr. Herbert Spencer has achieved what was at one time considered the hopeless task of completing his "Philosophy." It has taken 35 years. From the beginning it was recognised that there must be a big *lacuna* in the inorganic part of evolution which roughly corresponds to a theory of chemical properties, and the 35 years have done little to supply a means by which that gap can be filled.

Barbizon.—It is stated in *L'Etincelle Electrique* that an electric tramway is proposed from Fontainebleau to Barbizon, and, moreover, it is to go through "all the most beautiful parts of the forest." But we need not take that last statement too literally, or else a very sinuous course would be implied. It is to be hoped that the artistic traditions of the neighbourhood will result in producing something of hitherto unaccustomed beauty in the way of posts and overhead wire fittings.

Books Received.—We have received from Messrs. Whittaker and Co. the following books, which we hope to deal with in due course: "The Dynamo," by C. C. Hawkins and F. Wallis; "The Metric System," by W. H. Wagstaff; "Transformers," by Gisbert Kapp (translated from the German by the author); "Auto-Cars," by D. Farman, and "Carriages without Horses shall go," by A. R. Sennett.

Lighting in Paris.—It is stated in the *Revue Industrielle* that it is very difficult to get at the exact net cost price of electric lighting in Paris. Our contemporary therefore goes at some length into the accounts of the municipal central station supplying the Halles. Ultimately, figures are arrived at equivalent to about 5·2d. on the current generated, or 7·2d. on the current sold, this including, of course, charges for capital, etc. Probably the private companies do it much cheaper.

Stoppage.—A little while ago we noted how a short stoppage of a private installation was caused by a cat not having been properly educated as to the nature of dynamos. In France they have had a much more serious stoppage caused by a mouse. It took place at Busigny, on the Nord Railway, and, so far as one can disentangle the rather mixed account given by the *Daily News* correspondent, there was a short-circuit and some coils spoiled. The fuses went immediately the alternators were started.

Drying Telephone Cables.—A method now adopted throughout France for drying cables is stated to consist in forcing dry air through the lead pipes containing the cotton or paper insulated cables. The entrance of moisture in such cables renders them unfit for service. One of the advantages of the method is the facility of repairing faults; if a fault exists dry air is forced into the cable from both ends, which will after a few hours raise the insulation sufficiently to enable the cable to be used, after which the hole in the lead covering is soldered.

Circulars.—Prof. Oliver J. Lodge gets so many prospectuses and other rubbish (fancy calling a prospectus rubbish!) delivered by the halfpenny post that he wants the Post Office to provide at a nominal figure a rubber stamp, "Declined," wherewith to return the missives to the sender. Perhaps the Post Office would prefer that Prof. Lodge should burn or sell as waste paper the prospectuses instead of asking it to carry them all the way back for nothing. Moreover, the wicked senders might post them again in new wrappers to other professors.

Canal Working.—Mr. A. de Bovet has a long article or report in the *Revue Generale des Sciences* on the condition of inland navigation in France. Mr. Galliot's arrangements for electric towing on the Burgundy Canal are spoken of as a success, but no figures are given. It is considered that tow-boats warping along a chain are preferable to screw-tugs, as there is less disturbance of the water in the absence of the propeller, and consequently less cost for the maintenance of the canal. Mr. de Bovet thinks the final system of electric navigation on canals will be a trolley system with an extensible conductor to the barge.

A National Railway Museum.—In regard to the establishment of a national railway museum, an influential preliminary committee of 20 members (with power to add to their number), consisting of members of Parliament, engineers, railway officials, and others interested in the preservation of the history and relics relating to the railways of Great Britain, has been formed with a view to promote the foundation of a permanent collection of these interesting records of the railways. Any person interested

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in the subject should communicate with the honorary secretary to the committee, Mr. Clement E. Stretton, C.E., Leicester.

Block Signalling.—Readers of the articles by Mr. Pigg on "Block Signalling" who are ready in pursuing the subject further to tackle technical German may be interested to learn that in *Dinglers Polytechnisches Journal* (Stuttgart) of the 13th inst. there is an illustrated description of the Siemens and Halske apparatus for block signalling on single lines, the particular apparatus referred to being those erected by Max Jüdel and Co., of Brunswick, on the Brugg, Botzenegg, and Effingen line of the Swiss North-Eastern Railway. The arrangement is not a staff system, but one end of a section sending a train in blocks the other end.

Obituary.—The death has been announced of Mr. John Noble, formerly the general manager of the Midland Railway Company. The course of training requisite to produce a successful railway manager has not yet been specialised. Mr. Noble was intended to be a clergyman, actually became an accountant, and proceeded to the Midland Railway *viâ* the Clearing House. Being there he made his mark, not in accountancy, but by running fast expresses.—We regret also to hear of the death of Mr. William Charles Tyler, of the India Rubber, Gutta Percha, and Telegraph Company. A brief notice of Mr. Tyler's career is given elsewhere.

The Aarau Power-House.—The Aarau water-power station, which was visited on the occasion of this autumn's electrical congress at Geneva, is described in *L'Electricien.* The source of power is the River Aar. Reaction turbines are used, with alternators direct-coupled on the main shaft. At 48 revolutions these machines give two-phase currents at 2,000 volts. There is a pendulum regulation of the inlet gates. The exciter dynamos are also on the main shaft. There are three transmission lines. The town station is about half a mile off. These three motors, each working a pair of dynamos, convert the current into a continuous one for lighting purposes. There is also an accumulator of Tudor cells.

Motorcarts in Ireland.—The Local Government regulations issued for "light locomotives" in Ireland are mostly identical with the English ones, but the following appears to be an additional provision in Art. 4, Sec. 2: "Provided also that no light locomotives shall travel along any public highway within the limits of the Dublin Metropolitan police district, or of any city, town, or village at a greater speed than six miles an hour, or if its weight, unladen, exceeds two tons at a greater speed than five miles an hour." It is to be presumed that this will be construed to mean within the city or village streets, and not within the municipal boundary, but it would be well for the point to be made clear in view of the use of the term "district" in the line immediately preceding.

Russian Patents.—The French Society of Civil Engineers has been discussing the new Russian patent law. This received the Imperial approval in June last. There are the usual provisions as to "novelty," and Russians and foreigners appear to be placed on the same footing. There are, however, to be no "patent medicines" or patent foods, and patents for inventions relating to the military or naval services, though obtainable, will not run against the Government. A preliminary examination is retained, but the procedure is reformed, and an appeal provided for. The patent lasts 15 years, and the fees range from 15 roubles for the first year proportionately up to 400 roubles for the last (say from £2. 8s. to £64), but, of course, the patent can be abandoned at any time. The society had little to say on the subject, but regret was expressed that specifications were not published in France as in other countries. But that is a different matter.

Forthcoming Events.—To-day (Friday) the cycle and motor show begins at the Agricultural Hall, Islington.—At Glasgow Dr. Magnus Maclean delivers the presidential address to the University Physical Society.—On Monday (23rd) is the first Cantor lecture at the Society of Arts (Prof. Lewes on gas).—On Tuesday (24th) the paper at the Institution of Civil Engineers (Great George-street, 8 p.m.), is on "The Bacterial Purification of Water," and is read by Dr. Percy F. Frankland, F.R.S.—There is also a meeting of the Ediswan Company at Cannon-street Hotel called for Tuesday, and the Scottish Engineers and Shipbuilders meet at Glasgow on that day.—The Institution of Electrical Engineers' dinner is on Wednesday, at the Criterion (7.30). On the same evening Mr. Worby Beaumont lectures on motorcarts at the Society of Arts.—On Thursday, the Electrical Engineers discuss Mr. Gavey's paper on trunk telephones; and on Friday at Burlington House (5 p.m.) the Physical Society meets for Captain Abney's paper on the measurement of the efficiency of photographic shutters.

One-Man Companies.—The judgment of the House of Lords in Broderip *v.* Salomon may be referred to here, as it demands the attention of everyone who has dealings with private companies of the class of "So-and-So, Limited." The decision finally establishes the fact that it is now good law that any man can by associating to himself six dummies and paying the company registration fees free himself from all liability for his trade debts. It is generally understood that the letters "Ltd." give warning of that, but there is more. As "vendor" (to self and dummies) he can take payment in such an amount of debentures as will in any event make him a preferential creditor to an amount exceeding the trade assets. Mr. Justice Vaughan Williams invented a way of stopping this little arrangement quite in the old style, and the Court of Appeal (Lindley and Lopes, L.JJ.) backed him. But the law lords would have none of it, apparently holding that the day is gone by for judges to supply the defects in Acts of Parliament, so that the matter stands as explained above. It is sincerely to be hoped that this *reductio ad absurdum* of the operations of the Companies' Act may lead to speedy legislation on the subject of debentures.

The Kinetoscope.—The following lucid description of the way kinetoscope pictures are got is taken from a provincial contemporary, but its origin is evidently on the other side of the Atlantic: "Attached to the rear end of the camera is a thing which revolves at a great rate of speed, but which at certain intervals is stopped by an arrangement which pauses just sufficiently long to permit another thingamajig at the lens to open and so fix the actinic rays upon a continuous what-you-may-call-it at the other side. These work in conjunction, and so perfect is the arrangement that at soon as the first thing stops the second is brought to a standstill and remains so until liberated and started moving again by a little contrivance which is attached to the camera by a long arm attached to a piece of mechanism which moves at the same rate of speed. The negatives are then developed." A similar description of the kinetoscope follows, but the above is enough. To omit the following caution, which comes at the end, would, however, detract from the humour of the thing: "The kinetoscope is protected by patent, and any person desiring to make one by following the description given in this article is hereby informed that he may infringe upon the patent and find himself in a peck of trouble."

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Electro-Harmonic Society.—There will be a ladies' night on Friday, November 27, 1896, for which the following programme has been prepared. Part I.: violin, piano, and Mustel organ, "Andante Religioso" (F. Thomé), Messrs. T. E. Gatehouse, Alfred E. Izard, and H. M. Higgs; song, "Oh, how I Love Thee" (Pavy), Mr. Herbert Emlyn; pianoforte solo, "Rhapsodie, No. 8" (F. Liszt), Mr. Alfred E. Izard; sacred song, "Ave Maria" (Gounod), Master Percy Hale; hand shadows, Mr. David Devant; recitation, "The Faithful Mind" (Burdette), Mr. W. G. Churcher; song, "Looking Back" (Sullivan), Miss Alice Reed; humorous sketch, Mr. Cecil Barnard. Part II.: violin, piano, and Mustel organ, "Cantique de Noël" (Adam), Messrs. T. E. Gatehouse, Alfred E. Izard, and H. M. Higgs; new song, "The Light of the World" (S. Adams), Mr. Herbert Emlyn; violin solo, three "Lieder Ohne Worte" (Mendelssohn), Mr. T. E. Gatehouse; recitation, "My Experience with a Whistler" (Snazelle), Mr. W. G. Churcher; song, "Mavourneen" (Florence Aylward), Miss Alice Reed; Mustel organ solo, Overture "Semiramide" (Rossini), Mr. H. M. Higgs; song, "Cherry Ripe" (Horn), Master Percy Hale; humorous sketch, Mr. Cecil Barnard.

Meteorological Society.—The first monthly meeting of the Royal Meteorological Society for the present session was held on Wednesday, at the Institution of Civil Engineers, Great George-street, Westminster, Mr. E. Mawley, F.R.H.S., president, in the chair. Mr. W. Ellis, F.R.S., gave an account of the proceeding of the recent International Meteorological Conference which was held at Paris from September 17 to 23. The conference was attended by about 40 representatives from various parts of the world, Mr. Ellis being the delegate from the Royal Meteorological Society. The Hon. F. A. Rollo Russell then read a paper on "Haze, Fog, and Visibility." Haze is most prevalent when the wind is from the north-east, and is due, he thinks, to excess of dust brought about by conflicting currents. The causes of fog are to a great extent the same as the causes of haze, although radiation in certain states of the air and ground plays a more conspicuous part. The main cause of fog is mixture of airs of different temperatures, and the attainment of a size of water particle so much larger than in the case of haze is due to suddenness of mixture, greater humidity, or greater differences of temperature. The conditions favourable to visibility are dryness of the air near the ground-level, uniformity of temperature and moisture, radiation below the mean, steady and homogeneous winds through a great depth of the atmosphere, approximation of the temperatures of sea and land, and a number of dust particles less than the mean.

The Niagara and Buffalo Power Line.—At one minute past last Sunday midnight (it is well to be particular as to the exact moment) the "Mayor of Buffalo, with a distinguished company of his fellow-citizens, announced the formal receipt of electric power from Niagara Falls by a salvo of 21 guns," and the *Times* correspondent (by telegraph) has gone into unaccustomed raptures over the event. The whole of the Niagara business has been so "discounted" and anticipated that it has long ago lost all freshness for the technical Press. One circumstance, however, in connection with this 11,000-volt transmission line has been strongly impressed on us by some excellent illustrations of it that have appeared in the *Western Electrician*, and that is the extreme hideousness of some of the arrangements for carrying it. Wood posts with broad cross-arms are the usual run, and may pass where there is no scenery to spoil. But when the line gets sinuous there is set up, instead of posts, an arrangement which is something like a Rugby football goal, and something like those curious wooden erections which are put up to adorn the entrances of Buddhist temples, only a great deal bigger than either. If the object is to take the side strain, the device does not look a very happy one. The overhead line does not, however, come into the town, and the last three-quarters of a mile of it is through a conduit about 18in. below the surface of the ground. Already 10,000 h.p. has been contracted for in Buffalo, but how long it will be before the 22 miles between the Falls and the city will be "built solid with smokeless and teeming factories" remains to be seen.

Society of Arts.—The first meeting of the one hundred and forty-third session of the Society of Arts was held on Wednesday night at the society's rooms, John-street, Adelphi, when Major-General Sir Owen Tudor Burne, chairman of the council, delivered the opening address, the subject of which was "India: Its Arts, Manufactures, and Commerce." Those present included Sir Richard Webster, Q.C., M.P. (the Attorney-General), Sir Frederick Abel, Sir Charles Kennedy, Sir George Birdwood, Sir Douglas Galton, the Hon. Sir Charles Fremantle, Sir John Donnelly, Prof. J. M. Thomson, Mr. Alexander Siemens, and Sir H. Trueman Wood (secretary). The chairman alluded at the commencement of his address to the diversified character of the natural features of India, and pointed out that its vast population was as varied in character and thought as the Norwegian and the Italian, while, similarly, the climate had its extremes of heat and cold and of drought and rain. This great empire, he reminded his hearers, was protected by a military force which numbered about 73,000 European and 146,000 native troops, besides 30,000 volunteers; it was irrigated by nearly 41,000 miles of canals, traversed by nearly 20,000 miles of railways (none of which might be said to have existed half a century ago), and covered with a network of about 46,000 miles of telegraph line. As to usual features and products, the mountainous tracts of the Himalayas produced all the plants and species of European grain, fruits, and flowers, and the vegetable produce of the plains of India was the same as in all tropical countries. At the close of the address the chairman presented the society's medals gained during the last session. A vote of thanks was afterwards passed to him, on the motion of Sir Frederick Abel, seconded by Sir Douglas Galton. The first of the Cantor lectures will be on Monday next, November 23, at 8 p.m. It is on "The Use of Gas for Domestic Purposes," and will be delivered by Prof. Vivian B. Lewes. On Wednesday, November 25, (8 p.m.), is the second ordinary meeting, when Mr. W. Worby Beaumont, M.I.C.E., lectures on "Recent Developments in Mechanical Road Carriages." On this occasion Sir Frederick Bramwell, Bart., D.C.L., F.R.S., will preside.

Motorcarts.—In reference to the meet and procession to Brighton last Saturday, the Motor Car Club seemed to have made very few arrangements, or, if they were made, they were not carried out. Moreover, though we anticipated a great crowd, the police authorities apparently did not until it was too late. Consequently, things got a bit mixed. The weather was just as bad as it could be. Mud enough to make going bad, and not rain enough to clear the streets. Ultimately, about 30 motor vehicles got off somehow or other. Some stopped at Brixton, others joined in there. Almost all that seriously meant going to Brighton got there, so that, though as a procession the affair was an utter failure, as a demonstration that the motor cars can really go the distance it was a success. They had to contend with crowds, and when outside the regions of crowds with flying squadrons of cyclists. Mud all the way was a matter of course, and at the end it was driving rain and a head wind. The

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cars that observed the rules of the game got to Brighton about five o'clock. Two Bollée cars, which arrived nearly 2½ hours earlier, started from Brixton and did not stop at Reigate. Even so, however, there does not seem much room to spare for their performance inside the regulation limits of 12 miles an hour. All through the mud and muddle Mr. Lawson preserved his irrepressible spirits, and at the dinner at Brighton in the evening was ready to chaff the "friend of man" and the Walsall whipmakers. So far as it goes, the main result of the trial is to confirm our preconceived opinion, that the bigger the motor carriage, the better it goes. The failures were mostly of the tricycle type. As to safety, one little girl was run over by an American car at Crawley. The Home Office promptly held an enquiry, sending down General Carey to Crawley to investigate the cause. The police on duty, independent witnesses, and medical men were examined, and at the close of the enquiry the inspector said that so far as he could see no one was to blame for it. As the "procession" contained besides the Motor Car Club's approved vehicles experimental cars of all sorts, it would be unfair to lay too much stress on the fact that some of them created a great deal too much smell. For the rest there is little to record. The streets are not yet full of either electric cabs or steam omnibuses, but Mr. Walter Bersey has got himself fined twice more for anticipating the Act. He probably holds the record. The metropolitan police amused themselves by applying for a summons against Mr. Lawson for his motorcart in the Lord Mayor's Show, but the magistrate did not think it worth while. Moreover it is not clear that my Lord Mayor did encourage a breach of the law. There were certainly several flags in front, but whether one of them was red enough would of course have been a question for argument. The red flags of some traction engines are not quite as bright as a grenadier's tunic.

Statistical Society.—The Royal Statistical Society held the first meeting of the session 1896-97 on Tuesday evening at the Royal United Service Institution at Whitehall. Mr. Charles Booth took the chair, the president of the society (Mr. John Biddulph Martin) being prevented by illness from being present. His inaugural address on "Some Developments of Statistical Research and Methods during Recent Years" was consequently read by Mr. R. H. Hooker. The address pointed out, among other things, that electric locomotion was already beginning to furnish matter to be dealt with statistically, and it was impossible to say what might be the result during the next 60 years of the application of science to the service of man. It was conceivable that by that time some of the problems of aerial navigation would have been solved. Even the art of cycling, usually regarded as a pastime, was already beginning to exercise an economic influence. It was for the statistician to discriminate between the ephemeral phenomenon and the inception of an economic movement. [How is he to do it?] Also it was for statisticians to see that statistics are used in a strictly workmanlike manner. Cases had occurred in which they had been wilfully misused; misuse through carelessness was more frequent, and an imperfect statement of facts had in many cases led to divergent views on social problems. [The "social problem" people usually snap up anything which seems to make for their views. It is well to recognises the responsibility of putting dangerous weapons into their hands.] The address also dealt with the graphic method of statistics, with reference to the various forms of expressing statistical totals by geometrical figures, accompanied in some cases by the employment of colours. It was to be regretted that the use of the graphic method, which had sprung up automatically, had not been developed on any conventional lines. Were the employment of particular graphic forms invariably applied to the exposition of the same phenomena, and if this conventional agreement could be made international, the interpretation of statistics graphically presented would be vastly facilitated and might also serve to exchange ideas more efficiently than the illusive Volapuk of which so much had been expected and by which so little had been achieved. [So we are to go back to picture writing.] Reference was made to the application of the higher mathematics and the laws of probability to the elucidation of statistical problems, and the president said that abstract science, save as it bore on the improvement of the human race, had no interest for statisticians.—Why not? And how do they know whether "abstract science" may not be merely waiting for a "constant" in order to bring out a result of the highest practical importance? The way to test a "theory"—*i.e.*, an explanation—is to work it out and compare it with the facts, and some idea of what the facts are wanted for ought not to be without interest to an intelligent compiler.

The Telephone Service.—At the Durham County Council's quarterly meeting, the chairman (Mr. Storey) brought forward the telephone question The present state of affairs he thought was known to all business men to be not merely discreditable to the executive capacity of a Government department, but a very serious loss and trouble to all those engaged in the great industries of that county. In his judgment the whole of the difficulty arose because the Post Office Department adopted a half and half arrangement. The trunk lines were now in the hands of the Government, and the local work was in the hands of a company. He thought the Government ought to have had common sense to know that that sort of dual control did not work well in business any more than it did in the affairs of a nation. Mr. A. F. Pease said they could hardly expect the Duke of Norfolk, not being a business man, to know the effects of the present state of things, and ultimately a resolution condemning the position of things was carried. So much for the North. As to London, the letters to the *Times* have recommenced. Messrs. Hecht, Levis, and Kahn say: "Since the Post Office has taken over the trunk wires, we may safely say that the telephone has become the great impediment to communication. Before that time the service was not perfect, but the operator could at least, when you rang, reply at once, 'You can have them,' or 'There are so-and-so many before you.' When you ring now, the National Telephone Company ask you first, 'Do you want to speak three or six minutes?'—a thing you do not know yourself always. Then they communicate with the Post Office, which sometimes lets them wait 30 to 45 minutes before it tells them how many there are before the applicant. This morning we wanted to communicate with Liverpool. After 45 minutes' waiting we were told, 'There are 11 before you.'" A Government department does not answer newspaper correspondence. But it is possible that some sort of hint as to the lines such an answer would take may be assumed from a passage in Mr. Gavey's paper at the Electrical Engineers last week. Mr. Gavey, who ought to know, says subscribers fix their telephones in out-of-the-way localities and leave them in charge of office boys. The attention given is often bad, much time is wasted in ringing even before an answer is obtained, and more time is lost in fetching a responsible person to the instrument to deal with the matter in hand. In the meantime one of the subscribers is probably standing at his telephone unconscious

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of the cause of delay, and the result is, not unfrequently a series of bitter complaints addressed to the local Press. That would, however, hardly be a good answer to complaints of the company's service and the trunk lines not working well together. Moreover, "time" in an office is of various values, and there is at least the possibility that the office boy may be as qualified to call or answer the telephone girl as the senior partner himself. That young gentleman has usually keener ears and less to think about.

"Thermo-tropic" Cells.—It was Mr. C. J. Reed that killed that curiously devised giant, the Jacques carbon battery, in America, and now he and other American experts have been trampling on its corpse at the Franklin Institute. It will be remembered that Mr. Reed showed that it was from the heat of the enclosing furnace that the electrical energy of the Jacques cell was mainly derived, and that he could get similar results from quite different and chemically inert combinations. In fact, the whole thing was a thermo-electric arrangement. In the present instance Mr. Reed has been demonstrating that if two pieces of the same metal are separated by a film of their own oxide (or any salt), and one of them is heated, there may be a considerable E.M.F. across the junction. Such an arrangement Mr. Reed, for reasons best known to himself, calls a "thermo-tropic" junction. Unfortunately, the oxide is a very bad conductor. Prof. Elihu Thomson's view of the Jacques cell appeared to be that the function of the air blown into the fused caustic was to form a film of oxide on the iron pot. This oxidised the sodium produced by the reducing action of the carbon on the hot soda. (The oxygen therefore goes in at one end and comes out at the other as carbonic anhydride, the iron and soda being regenerated.) But if that is so then the cell is not a thermo-electric one, which does not seem to be the case. Nor is it even endo-thermic if no other operations go on. Moreover, as Mr. Reed replied, the caustic at the temperature used would certainly contain a sodium ferrate, and if there were any reduction the iron would be reduced before the sodium. This may be good enough as an answer to any attempt to galvanise the corpse into renewed life, but Mr. Reed will not be so easily followed when he goes on to suggest that the proper things to use instead of fused caustic soda would be alkaline arsenates and arsenites, chromates, and, in fact, all the "acid" metals in the table of elements and some others which are only hypothetically acid-forming and at high temperatures. There can be no possible objection to experiments of this sort, though they are hardly likely to lead to much. The life assurance people might object to the fused arsenite cells, but that is a side issue; when they come into use it will be time enough to think of safety rules. Mr. Reed, however, seems to think such cells must be failures because they devour themselves. As with the galvanic battery, "the evolution of electric energy depends upon and is commensurate with the mechanical destruction of the apparatus itself, the cost of renewing which is always much greater than the entire cost of the fuel." After all it did for them in the days before the dynamo, it is unkind of an electrician to talk of galvanic batteries in that way. Moreover, if thought out it will be seen that there is nothing in it provided a way can be discovered of using cheap materials. Moreover, though Dr. Jacques's hot alkali may be no better than Dr. Coehn's hot acid, the relations of various combinations at high temperatures have not yet been worked out and recorded. They are altogether different from those at ordinary temperatures. There is just that last chance remaining for the primary battery inventor.

Two Books.—We have received from the D. van Nostrand Company, 23, Murray-street, New York, Mr. E. P. Thompson's book on "Röntgen Rays." It consists of 13 chapters of abstracts of contributions to societies or technical papers more or less connected with the subject which forms the title of the book. The first is Faraday's experiment on induced currents (1831) A mass of "communications" is thus got together which will greatly facilitate the historian's labours when the history of the discovery comes to be written, and which will be consulted, at any rate in the first instance, by those who undertake the dismal duty of settling questions of priority. If, however, concerning some of these it would be well to bear in mind the caution given the other day by Captain Abney as to implicitly accepting as correct all, for instance, that is published in the *Comptes Rendus*, the compiler is hardly to be blamed. Mr. Thompson's original matter consists of a *pro formâ* introduction (2½ pages) and a preface. In the latter it is said, "The author has prepared himself to withstand with about half as much patience as he expects will be required all the criticisms based upon disappointments which may be experienced by the true, or the alleged true, first discoverer of any particular property of the electric discharge not duly credited. He has been particular in presenting knowledge as to physical facts and principles, but not equally, perhaps, as to the originator of the experiments or as to the actual first discoverer, for the simple reason that the book is in no sense a history nor a biography. Where the paragraph has been headed, for example, 'Swinton's Experiment,' it means that that party (according to the article purporting to be written by him) made that experiment. Someone else may have made exactly the same experiment previously, yet the instruction is equally valuable as though the researches of the first discoverer had been related. On the other hand, the author has never had any intention of giving credit to the wrong party. The dates in the captions indicate the general chronological order in behalf of those thus interested." The style grates somewhat upon the British ear. Mr. Thompson also states that the Röntgen rays are never generated in air or anywhere else than in "a highly evacuated enclosure." To say the least, the qualification "in any great quantity" is needed before it is quite "safe to assert" that. It may be added that the "haloes" of page 143 could probably be explained by a photographer. There is a short chapter on "Theoretical Considerations' by Prof. W. A. Anthony. That gentleman does not commit himself to anything, but appears to be of opinion that the difficulty of getting diffraction fringes shows that the rays cannot be a wave motion. Of course all that it shows is that waves of different lengths have not widely different effects on the photographic plate or fluorescent screen used, but he adds an extract from *Comptes Rendus* which would make the rays infra-red. There are a quantity of excellent reproductions of Röntgen photographs scattered up and down the book.—The second book is Mr. F. J. Britten's "Watch and Clockmakers' Handbook" (E. F. and N. Spon, London), the receipt of which has been already noticed. When a book reaches its ninth edition it is past review, but occasion may be taken to refer to the excellent practice adopted of giving the French and German equivalents of all the technical terms used. These are all collected in the end, so that as far as its subject-matter goes the book serves also as a technical dictionary of the best type. Would that the practice were more common in works of this kind, for no man can know the proper equivalent of every machine "part," even in a foreign language with which he is familiar, and whoso trusts in those matters to the ordinary dictionary finds it "a fraud, a delusion, and a snare."

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THE PRINCIPLES OF ALTERNATE-CURRENT WORKING.*

BY ALFRED HAY, B.Sc.(EDIN.), A.I.E.E.

(Continued from page 543.)

98. The action of a condenser when connected as a shunt to an inductive resistance may be thus explained in general terms. The total current in the inductive circuit may be analysed into two components: the *load* current, which is in phase with the impressed E.M.F., and the *idle* current, which is in quadrature with it (Art. 62). The idle current transfers the *stored energy* to and from the inductive circuit. Now, this idle current is $\frac{\pi}{2}$ behind the E.M.F. as regards phase, and the current of the shunting condenser is $\frac{\pi}{2}$ in advance of it. Hence these two currents are always of opposite sign, so that when the idle current is, say, flowing from a to b (Fig. 67), the condenser current is flowing from b to a. We shall thus have a *local current in the branched circuit which does not pass into the main circuit at all.* If the capacity of the condenser is so adjusted that its current is equal to the idle current of the inductive resistance, then it is obvious that the only current in the main circuit will be the load current. *The load current represents the minimum value which the current in the main circuit may have.* For if the idle current in the inductive resistance either exceeds or falls below the condenser current, then the excess of current must pass into the main circuit, and hence the current in the latter will be increased.

There is a fallacy connected with this problem of a shunting condenser to which it may be well to allude. It is the notion that the condenser in some mysterious way becomes a source of power, and develops energy of its own accord. All the condenser does, however, is simply *to relieve the main circuit of the idle current.* The energy which is stored up in the magnetic field of the circuit, instead of surging between the inductive resistance and the source of E.M.F., surges between the former and the condenser. The condenser, in fact, acts as a convenient reservoir for the discharge of the stored energy from the inductive circuit.

99. Advantage is taken of this effect in some cases for the purpose of increasing the power factor of the circuit (Art. 59). The advantages resulting from working with a high power factor have already been briefly considered in Art. 60. Thus, let us suppose that a 6,000-watt transformer of the open magnetic circuit type is found to take a primary current of 1·194 amperes when connected across 2,400-volt mains, the secondary circuit being open; and that the *true watts* (Art. 59) as measured by a wattmeter amount to 151. The *apparent watts* are in this case equal to $2{,}400 \times 1{\cdot}194 = 2{,}866$ watts, so that the power factor is only $\frac{151}{2{,}866} = {\cdot}0527$. The problem is to find the capacity of a shunting condenser which will render the power factor for the mains equal to unity, the periodicity being 83 ∿ per second.

In working out this example we shall assume that the E.M.F. and currents obey the simple sine law—an assumption which would in most cases not be justified in practice. But in the case of problems like the one in hand such an assumption leads to results which are sufficiently correct for practical purposes.

A glance at Fig. 68 will show the student that the relation between the total current, the load current, and the idle current may be represented by the three sides of a right-angled triangle. If, therefore, two of these quantities are known we can at once determine the third. Thus, referring to Fig. 71, we see that, the triangle being right-angled,

$$\textit{idle current} = \sqrt{(\textit{total current})^2 - (\textit{load current})^2}.$$

In our example the total current is 1·194; the load current is $\frac{151}{2{,}400} = {\cdot}0629$. Hence

$$\text{idle current} = \sqrt{1{\cdot}194^2 - {\cdot}0629^2} = 1{\cdot}192 \text{ amperes.}$$

* Based on a series of evening lectures delivered at the University College, Liverpool.

We have therefore to provide a condenser which will take this idle current of 1·192 amperes at 2,400 volts and a periodicity of 83 ∿ per second.

By Art. 91, equation (25), we have, if C denote the capacity of the condenser,

$$C = \frac{1{\cdot}192}{p \times 2{,}400}.$$

Now $p = 2\pi \times 83$, and we find $C = {\cdot}9513 \times 10^{-6}$ farads, or ·9513 microfarad. A shunting condenser of this capacity will therefore render the power factor for the mains equal to unity, so that the current which flows into the transformer from the mains is only ·0629 ampere, instead of 1·194 amperes, which is its value when the condenser is removed.

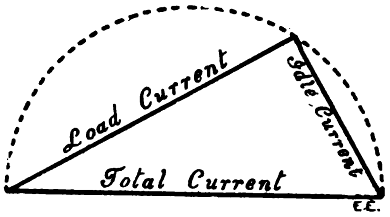

FIG. 71.

100. In all the above investigations we have assumed that the condenser current is a quarter-period $\left(\frac{\pi}{2}\right)$ in advance of the impressed P.D. at its terminals. If this were strictly true, then a condenser would absorb absolutely no power (Art. 61, Prop. II.) and the whole of the energy which is stored up in it during the first half-period, when the current is positive and the charge in the condenser is increasing, would be returned to the source of E.M.F. during the next half-period, when the current is negative and the charge diminishing. As a matter of fact, however, a condenser *does* absorb a certain amount of power, so that there is a small component of the current which coincides in phase with the impressed P.D., and hence the actual current is a little less than $\frac{\pi}{2}$ in advance of the P.D. A condenser, in fact, behaves as if it were a combination of a *perfect condenser—i.e.,* one which causes no dissipation of energy—with a small non-inductive resistance connected in series with it; this equivalent resistance may be termed the *spurious resistance* of the condenser. The small load current of a condenser goes towards producing heat in the dielectric, which gets warmed up by the repeated alternating stresses to which it is being subjected; and a condenser which has been kept working for some time shows a marked rise of temperature.

101. The effects which we have been considering may be briefly summed up by saying that a condenser of suitable capacity connected in series with an inductive resistance may be used for producing a rise of P.D. across the terminals of this resistance; and a condenser connected as a shunt to an inductive resistance may be used for supplying the idle current required by that resistance.

Cases more complicated than those we have dealt with may present themselves, but the student who has followed the preceding explanations will have no difficulty in obtaining, by means of suitably constructed vector diagrams, similar to those of Figs. 66 and 68, the solution of any problem involving combinations of a resistance, an inductance, and a capacity.

(To be continued.)

RAILWAY BLOCK SIGNALLING.

BY J. PIGG.

(Continued from page 545.)

Fig. 91 represents diagrammatically the arrangement of circuits where switching from "intermediate" to "through" sections is in operation. As will be seen, an additional line wire is provided for the "through" section instruments at A and C, and switches are provided at these places by which the batteries may be used for either the "inter-

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mediate" or "through" instruments. The main switch by which the change over is effected is situated at B. It consists of two distinct sets of switches of four each; one set being operated by depressing the tapper key, the other set being operated by the arrow-shaped handle. The four switches shown in connection with the key are in their normal position, and change of position of the contact points can only be *maintained* by keeping the key depressed. The four switches on the left will maintain upper and lower contacts according to the position of the handle by which they are operated. The operation of the left-hand contacts from top to bottom, or *vice versâ*, is controlled by locks which are released by the action of two electromagnets of similar construction to that used in connection with the staff lock and shown in Figs. 87 and 88. When the bell keys of the intermediate instruments at A and C are held down, and the similar keys of the two instruments at B are pegged down, depression of the tapper key on the switch causes currents to pass, from A and B, through the coils of one electromagnet, and currents from B and C through the coils of the other. If these currents are in "phase" with each other the electromagnets are energised, but not otherwise, and the handle of the left-hand set of switches may be turned. Assuming that the left-hand switches occupied the positions shown by Fig. 91 before the "intermediate" will show that only one of the releasing electromagnets (the lowest in Fig. 91) will be in use for this operation, the currents from A and C passing through different coils of the same electromagnet which operates on the one lock in this position.

Consideration of the system as a whole will show how absolute the control of the staffs and the switching out of intermediate stations actually is. In all cases of switching the three men at A, B, and C are all actively engaged, and the operation cannot be performed by any two of them alone. Not only is this the case, but owing to the fact that the switching currents must be in "phase" the possibility of error from attempting to switch when a staff is out of any one of the six pillars is prevented. Indeed, so highly is the system approved by Board of Trade officials that they allow fixed mechanical signals to be dispensed with at stations, situated between the staff stations, at which trains are required to stop.

Another feature connected with the switching out of intermediate stations during the times when traffic is known to be slack, other than the saving of wages, etc., is the possibility of using one set of instruments when, from any such cause as a line fault, the set in use has failed. This is an advantage which is not to be despised where traffic is heavy.

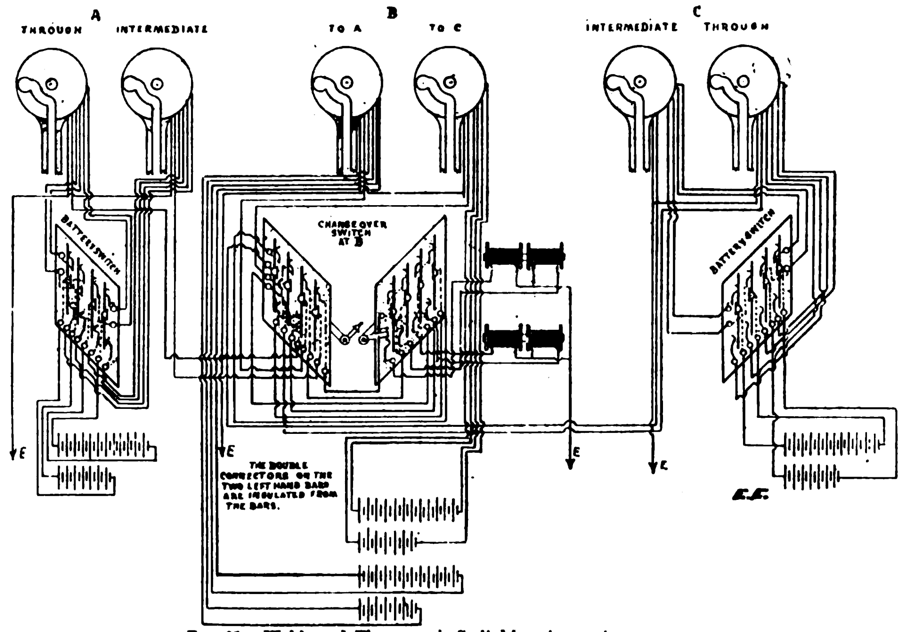

FIG. 91.—Webb and Thompson's Switching Apparatus.

operation commenced, the movements indicated will, if traced, be found to have disconnected the line wires of the "intermediate" instruments, situated at A, B, and C, at B's switch, and to have joined the "through" section line wire through at the same place. By altering the positions of the battery switches at A and C, the batteries previously used for the "intermediate" instruments are connected to the "through" instruments. Further consideration of the connections will show that the switches on the right of the change-over switch are simply used for the purpose of directing the currents set up by the depression of the keys of the instruments at A, B, and C, through the releasing electromagnet coils, and their use is temporary only. The actual change of connections is made by the left-hand switches. Further consideration of the diagram will show that the movement of the left-hand switches breaks the circuits from A, B, and C, through the lock coils and releases the locks and thus prevents the left-hand switch handle from being replaced in the position from which it has just been moved without the whole operation being repeated on the other instruments.

The operations just described constitute the change from "day" to "night" or "intermediate" to "through" instruments. The reversal from "through" to "intermediate" is similarly made, but as B has no instruments on the "through" circuit the pegging of the instruments at B is not a feature of this operation. Consideration of the conditions obtaining in switching from "through" to "intermediate"

Consideration of the instructions issued for switching show clearly that the instruments must be supplemented by some other means of communication in order that the various stages of the operation may be arranged and its completion reported. Where such means of communication do not exist it must of course be provided, and constitutes an additional expense, but there are few places now which are not provided either with a telegraph instrument or a telephone, and there will be less in the future.

(*To be continued.*)

INTERNATIONAL SUBMARINE TELEGRAPH MEMORIAL.

BY AN OCCASIONAL CONTRIBUTOR.

The following extraordinary letter appeared in the *Morning Post* a few days ago:

To the Editor of "THE MORNING POST."

Sir,—I have only just seen a letter signed "X. Y. Z." in a recent issue of your journal, and I would like to ask upon what grounds your correspondent states that the first submarine telegraph concession was granted to Mr. Jacob Brett in the year 1847. I have always understood that the concession granted by the British Government in 1847 was so granted to Mr. West, who was prevented from proceed-

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ing with his submarine cable scheme for connecting France and England by the dilatoriness of the then existing French Government, which was shortly after overthrown. Further, Mr. Brett's scheme was, I believe, on all fours with that of Mr. West's, except when it came to the question of laying the cable, and then Mr. Brett's methods proved utterly useless for the important work he was engaged upon. It was about this time that guttapercha was first introduced, and Mr. West was a strong opponent of the use of this material for submarine cables, he urging that indiarubber only was a suitable insulator. My object in writing to you is not to increase the number of names identified with the inception of submarine telegraphy, as this has already been overdone; otherwise, I should certainly wonder why Mr. T. N. Gisborne's name has never been mentioned in the newspaper correspondence upon this subject. The importance of submarine telegraphy to diplomatic and commercial interests seems to me to lie in its marvellous extension to all parts of the world rather than to the question as to who first conceived the idea of connecting the countries of the world telegraphically, and surely, if this is so, the names of nearly every person mentioned in connection with the movement now on foot should occupy a relatively insignificant position to those whose names are identified with the memorial now being developed. At any rate, the place occupied by the late Sir James Anderson (and to some extent this remark applies also to the late Sir John Pender) is, I feel, altogether misunderstood by many of the writers. Sir James Anderson was, I believe, empowered in the very early days of submarine telegraphy to form companies, obtain concessions, and generally negotiate for the laying of submarine cables, and this apart altogether from his connection with the famous cable-laying expeditions of the "Great Eastern" steamship, and he spent the remainder of his life in active telegraph work. With regard to the letter of Mr. Charles Bright, in which he mentions the name of Sir F. C. Paseley, R.E., and his 1838 experiments, I would point out to Mr. Bright that Mr. West was engaged during the Canadian Rebellion in 1838 (in connection with the Intelligence Department of the Government) in effecting subaqueous telegraphic communication across the Canadian rivers. It was in connection with this service also that Mr. F. N. Gisborne (who in the fifties introduced the subject of Atlantic telegraphy to Mr. Cyrus Field, and who subsequently became chief of Canadian Telegraphs) was first engaged in telegraphic work. The omission of Mr. West's and Mr. Gisborne's names from the very extensive (and growing) lists of names now coming so boldly to the front must, I presume, be attributed to the fact that much of their early work was done out of England, and consequently out of sight of those who came many years after them. Finally, were not almost all the names in these lists those of men who acted in the capacity of employés carrying out the instructions of their superiors, and where this is not the case, have they been in any way associated with the great extension of ocean telegraphy which the last 30 years have seen? Surely even a prominent place in the early Atlantic work does not entitle them to any but a very small share in the by far greater glory of the perfected systems which now exist. It is asking the public to identify Watt with the quintuple expansion engine.—Yours, etc., G. T.

P.S.—By the way, was not the first British submarine telegraph company actually formed in 1846?

From the above letter, it is evident that Mr. West and Mr. Gisborne have had the privilege of finding favour in "G. T.'s" eyes, though it is convenient to him to ventilate the idea that "the number of names identified with the inception of submarine telegraphy has already been overdone."

In the next sentence "G. T." evidently wishes to lose sight of the actual title of the memorial as then proposed, though remembering it apparently in his previous remarks. The fact is, "G. T." obviously desires to see a memorial erected to Sir John Pender and Sir James Anderson—principally to the latter, apparently—under some important title *apropos* of submarine telegraphy, and with Cyrus Field put in as a makeweight for purposes of internationality. To carry out this design it would have been better if some other prefix had been given to associate these names with than that out of the inception and extension of submarine telegraphy, in order to meet the views of others not educated up to the same notions as "G. T." These financiers had about as much to do with the inception of submarine telegraphy as "G. T." appears to have had; and their association with the extension of submarine telegraphy was of a purely commercial character. Submarine telegraphy, as a branch of engineering, was naturally got into shape by engineers and electricians before financiers could do anything with it, either by putting their hands into their own pockets or by appealing to the public. "G. T." might also have the consideration to remember that the brothers Brett came forward as financiers to submarine telegraphy long before any of the three names which he finds so necessary an accompaniment to the title, but which he considers it should be strictly confined to. At that time the Channel cable was just as great an undertaking as the Atlantic cable was later on.

The attempt to persuade the public any longer that Sir James Anderson was responsible for the 1865 and 1866 Atlantic cables having been given up, "G. T." now, for the first time, puts the work done by Sir James in its true light. Such work, however, scarcely warrants a memorial to him and two others of his sort as representative pioneers of submarine telegraphy in place of those scientists and engineers who rendered the thing possible and a subject for financial exploitation.

The interests which "G. T." has at heart are fairly clear, but his arguments are not equally so.

I have seen several names put forward as more suited than the three financiers named as pioneers, and can safely say that most of these have taken very important parts in the "extension of submarine telegraphy of the last 40 years," which "G. T." finds it convenient to lay special stress on. The question arises as to what "G. T." calls a "mere employé." We are all, I suppose, employés of somebody in a sense. Would he describe the engineers of the Forth Bridge or the Tower Bridge as "mere employés carrying out the instructions of their superiors"? Does he regard the engineer, or firm of engineers, to the owning companies of submarine cables as "mere employés"?

The concluding sentence of "G. T." runs as follows: "Surely even a prominent place in early Atlantic work does not entitle them to any but a very small share in the by far greater glory of the perfected systems which now exist. "G. T." thinks, moreover, "it is asking the public to identify Watt with the quintuple expansion engine." A sentence of this kind lays itself open to serious criticism all round. In the first place, the subject of the proposed memorial was to the *inception and extension* of submarine telegraphy. But even if it had been to the *extension* only, most people would recognise that what "G. T." is pleased to designate "the far greater glory of the extended system which now exists" only came within the sphere of practical politics in virtue of the earlier work carried out by those pioneers whom "G. T." thinks "should occupy a relatively insignificant position to those whose names are identified with the memorial now being developed."

I should imagine that if anyone were proposing to erect a memorial to the steam-engine, and if names were to be identified therewith, the very first on the roll would be that of Watt. Certainly, the quintuple expansion engine could scarcely be a *fait accompli* but for Watt.

Had "G. T." been present at the meeting (concerning the memorial), and had he heard the remarks of Lord Kelvin, I cannot help thinking, according to all reliable reports, he would have been unwillingly forced to come to a somewhat modified conclusion. Lord Kelvin said he had read the correspondence in the *Times* on the subject, and that he agreed with every word. His lordship also drew attention to the circumstance that the late Sir Charles Bright was the first to lay a cable in deep water, and pretty clearly pointed to the fact that if any names require special mention in regard to submarine telegraphy, Sir C. Bright was certainly one of the first three deserving recognition. This view was not probably quite welcome to some of those present.

However, the matter has now been settled in a different way, and it is to be hoped we shall not hear any more of

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immortalising the names of three financiers in association with any such title as "The Inception and Extension of Submarine Telegraphy"!

ON CHEAP STEAM POWER.

(Continued from page 556)

We have received from Mr. J. S. Raworth a small addition to his paper on the above subject, which was read before the Northern Society of Electrical Engineers. He also sends us a letter replying to the discussion, which we also give below. It will be noticed from the curves that the steam consumption curve for the Universal engine is not a straight line, as is usually the case for high-speed engines.

The conditions which prevail in the last example quoted are in some respects similar to those which so severely worry the brains of the chiefs of our electric supply stations—namely, variable load with an average much below the maximum. It is in cases of this kind that the advantages of automatic expansion show themselves more decidedly than with a steady load, as, for instance, in a cotton mill. Probably the best exposition of this subject is contained in Captain Sankey's paper on the "Governing of Steam-Engines," read before the Institution of Mechanical Engineers in 1895. In that paper Captain Sankey shows curves of the total water consumption with automatic expansion, as calculated and as obtained in practice and both compared with the Willans straight line diagram. The conclusions he arrives at are as follows: (1) that the theoretical gain by automatic expansion is less for high pressure than for low; (2) that the gain is less in practice than in theory; (3) that as the mean pressure is reduced a point is reached below which the consumption is greater with automatic expansion than with throttling, and that for 150lb. initial pressure this point corresponds with a mean pressure of 14lb.

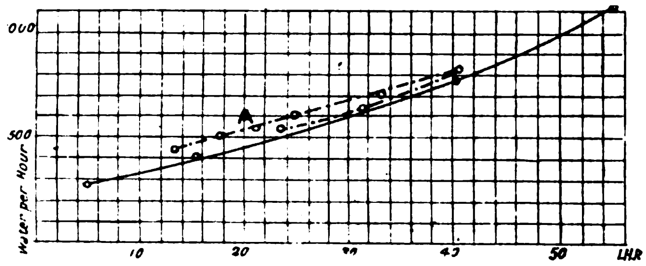

FIG. 1.

In the diagram (Fig. 1) I have plotted the results of three tests made under nearly identical conditions; the upper or straight line is taken from Willans's non-condensing trials; it is a constant expansion curve. The second short curve is from the same engine with varied expansion; the third and lowest curve is from a Universal engine of the same stroke as the Willans, but with a 14½in. low-pressure cylinder in place of 14in. It will be observed that whereas the middle curve if produced downward would cut the straight line at the point marked "A," representing 20 h.p., the lower curve never cuts it, and therefore maintains superior economy over the constant expansion to the last. This is due to the fact that the automatic shaft governor at light loads not only cuts off early but also throttles the steam, thus reducing the range of temperature within the cylinders. The main practical result is, therefore, that the Universal engine fitted with the shaft governor is at all loads more economical than a throttled engine, and that from half-load to full load the consumption per indicated horsepower is nearly constant. The saving in the cost and worry of working an electric lighting plant will be so obvious to all that I need not further enlarge upon it.

Having now given you my views on the subject of cheap steam power, illustrated by examples, which at best are only comparative—for in the nature of the case it is obviously impossible to select an example of each class that would be accepted by all engineers as a correct average—and having indicated one method by which I believe the cost of steam power may be reduced, to some extent, at least, with every existing class of steam-engine, and particularly with the high-speed vertical, I desire, in conclusion, to offer my humble tribute of admiration and of obligation to the memory of the late Peter William Willans. Not only did he give us clear and practical expositions of the theory of the steam-engine, but he also gave us experimental data so varied and so voluminous that in his "Steam-Engine Trials," "Condensing and Non-Condensing," one may find an example to fit almost every case.

Probably the most important feature of those trials is the fact that they were made on the same engine, in which, without doubt, the leakage was very small, but whatever it was the conditions remained practically constant throughout. Ordinary engine trials made on different and dissimilar engines are often extremely misleading, for many a well-designed engine fails to do justice to itself simply because the valves and pistons accidentally allow steam to pass. Thus the good points of the general design are beclouded.

There is another aspect of Mr. Willans's work which I think has not received sufficient recognition—namely, that he demonstrated that short stroke did not necessarily involve, as it was then believed to involve, either mechanical loss of power or loss of thermal efficiency—in fact, he obtained results with an unjacketed engine of 6in. and 14in. low-pressure cylinder which are difficult to beat in any size or any design of steam-engine. These results, although they are much better than those usually guaranteed to purchasers of Willans engines, were, I firmly believe, fairly and honestly obtained, and they have done more to stimulate and encourage the engineering profession than anything that has been done or said in my time. Although I am much indebted to Willans, I am more so to Corliss, for without the Corliss valve the Universal engine, if it could exist at all, would be but a mere makeshift; the very essence of its economy would be absent.

The following is the reply to the discussion:

The discussion on my paper on cheap steam power before the Northern Society of Electrical Engineers brought out one fact very clearly which I had not previously appreciated—viz., that the valves of the "Universal" engine are not generally understood. Both Mr. MacLaren and Mr. Ferranti spoke under the impression that the valves were of the cylindrical pattern, depending for steam-tightness on their fitting accurately the valve casing. I freely admit that the published drawings distinctly favour this view, and I find no fault with my critics for expressing it. The actual facts are as follows: The high-pressure valve seating is lapped out accurately to gauge; the valve is then carefully fitted so that it may be quite steam-tight when the engine leaves the works. The valve is then put in a lathe eccentrically and rather more than half of its circumference reduced, so that it may bear solely on the surface adjacent to the ports. The valve is as free as any Corliss valve to follow up as it wears. The cylindrical form is chosen partly for strength and partly in order that steam may enter freely from one end of the valve-box. The low-pressure valve is arranged with a preponderance of pressure towards the lower ports, so that it may always wear in that direction. The tendency, of course, is to render the upper or high-pressure port leaky, but that is of no moment, for the upper part of the valve may be cut away without permitting steam to pass. I retain the upper part, however, for two reasons—firstly, to facilitate manufacture; secondly, to interpose a door between the live steam and any water which may be left lodging in the valve from the preceding stroke. Should any serious wear show itself in this valve it will then become simple Corliss, neither better nor worse. The Universal engine as made by the Brush Company is a combination of many parts, some being novel and some merely developments of existing ideas. The arrangement of cylinders and valves is, however, applicable to any engine, and the object of my paper was principally to show that the theoretical and practical knowledge which we possess of the action of steam within the cylinder leads to the belief that the adoption of this construction in combination with any existing pattern of steam-engine would reduce both prime cost and working expenses. The test figures of steam consumption were adduced merely as collateral evidence in support of this view; they were not actually necessary, because the theory of the steam-engine is now sufficiently firmly established to enable the performance of an engine to be approximately estimated from the drawings.

INSTITUTION OF ELECTRICAL ENGINEERS.

At the opening meeting of the session on the 12th inst., the president (Dr. John Hopkinson) in the chair, after the usual formal business, and before proceeding with Mr. Gavey's paper on trunk telephones,

The **President** said that under the new arrangements the appointment of the Council for the year came before them that night. As these came into force now for the first time, some explanation of the procedure might be desirable. After reading Article 43, which regulates the election, the President said it would be seen that at the ordinary general meeting which occurred 28 days before the annual general meeting the chairman was to announce a list of candidates prepared by the Council, and any 10 members might nominate additional names, and must send them in, with the written consent of the nominee, within seven days, after which these names would be added and the whole list go to ballot. The "house list" was subsequently read as follows.

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PRESIDENT.

Sir Henry Mance, C.I.E., M.I.C.E.

VICE-PRESIDENTS.

*Robert Kaye Gray.
*Prof. S. P. Thompson, D.Sc., F.R.S.
†Prof. John Perry, D.Sc., F.R S.
†Joseph W. Swan, F.R.S

ORDINARY MEMBERS OF COUNCIL.

*G. von Chauvin.	†Prof. J. A. Ewing, F R S.
*Henry Edmunds.	†W. P. J. Fawcus.
*S. Z. de Ferranti.	†Major R. Hippisley, R E.
*W. E. Langdon.	†E. Manville.
*Prof. J. A. Fleming, M.A., D.Sc , F R.S.	†J. S. Raworth, M I C E.
*Dane Sinclair.	†James Swinburne, M.I.C.E.
†S. L Brunton.	†Herbert Taylor, M.I.C.E
	†Charles Henry Wordingham.

ASSOCIATE MEMBERS OF COUNCIL.

*Captain W. P. Brett, R.E.
*H. W. Miller.
*Sydney Morse.

HONORARY AUDITORS.

Frederick C. Danvers.
Augustus Stroh.

HONORARY TREASURER.

Prof. W. E. Ayrton, F.R.S. (past-president).

HONORARY SOLICITORS.

Messrs. Wilson, Bristows, and Carpmael.

* Remaining in office. † New members of Council.

It was the intention of the alteration to secure that the new officers and members of Council should be those really elected by the members, and it was desired that the new arrangements should be taken advantage of, and not remain a dead letter. The reason why the consent of 10 members had been fixed on was to ensure that the candidates put forward should stand a reasonable chance of election, and the consent of the candidate was imposed in order that elections might not be made which would prove ineffective owing to the candidate not attending. Beyond this he (the President) would like to refer to the retirement of Sir David Salomons from the office of honorary treasurer. Sir David had been a most admirable treasurer, and, though they had been able to find an admirable successor, it would be impossible for him to discharge the duties of the office better than Sir David Salomons had done, and it should be distinctly understood that the Council felt very great regret at the loss of his services.

Mr. A. Campbell Swinton asked why the very important business before them had not been notified in the notice of the meeting. He had enquired about it not more than 20 minutes before the meeting and could not find out if it would come on or not. He did not think one tithe of the members were aware that it was to come on.

The **President** said the time for bringing out the list was specified in the articles.

Mr. Swinton intimated that he would move that notice should be given in future, and a discussion whether this would or would not be in order seemed likely, but was averted by an intimation that in future a notice of the kind desired should be given by the secretary.

The meeting then proceeded to the reading of Mr. Gavey's paper, a portion of which has already appeared in our columns, and the continuation of which we give herewith :

THE TELEPHONE TRUNK LINE SYSTEM IN GREAT BRITAIN.

BY J. GAVEY, MEMBER.

(Concluded from page 547.)

Hitherto, the capacity of underground insulators, which roughly equalled 0·3 of a microfarad per mile, seriously limited the use of subterranean conductors. The capacity to earth of paper cables has already been reduced to a figure varying from 0·06 to 0·08 microfarad per mile with small conductors weighing 20lb. to 40lb. per mile; and although these are not well adapted for long trunk circuits, their use for relatively short circuits will soon become general. For heavier conductors, weighing 100lb. or 150lb. per mile, the capacity to earth is about 0·1 microfarad per mile.

The growth of the trunk system of this country, at first slow, has received a remarkable impetus since the Post Office has determined on its present policy. The first trunk circuit in Great Britain was erected between Cardiff and Newport, and was opened in August, 1881. Shortly afterwards a second loop was erected. Next followed two metallic circuits between Liverpool and Manchester, opened January 27, 1882; and in May, 1883, two trunk circuits were erected between Newcastle and Sunderland. The system grew slowly, as the local telephone exchanges increased in size, until the year 1884, when the various telephone companies were authorised to erect trunk wires between any of their exchanges. They then commenced the erection of a trunk-wire system which has now been acquired by the State. At the end of the year 1895, the mileage of telephone trunk wires in Great Britain and Ireland, actually complete or in course of completion, had reached the following figures:

	Miles.
Post Office system	20,522
National Telephone Company's system	28,999
Giving a grand total of	49,521

Further and rapid growth may be confidently expected, so that the present mileage will soon be largely exceeded. Every great town in the country is, or will be, connected with the telephone trunk wires of the State; and it is probably not unsafe to predict that within the course of a few years practically the whole of the commercial business of the country will be transacted by telephone. In neighbouring manufacturing and commercial districts this condition of things has already been nearly attained.

The method of working the telephone trunk system of the country, with due regard to all the interests at stake, has been a matter of careful consideration on the part of the Post Office Department in conjunction with the responsible officers of the Telephone Company. The acquisition of the whole of the trunks by the State involved the application of the maxim that "no favour should be shown and no priority given," but that all her Majesty's subjects, whether subscribers to exchanges controlled by the Department or by private companies, or non-subscribers using call offices, should be placed on an equal footing, and have an equal right to the use of the trunks in the order of application. This involved as a first step the termination of the trunk circuits at the post offices of the towns served—a course which has accordingly been followed. Every such post office is fitted with one or more silence cabinets at the public counter, where communication can be obtained through the switchroom with the trunks serving the town, and through them with any part of the country. Although, however, communication from public silence cabinets, in the manner provided for, is at times of considerable convenience to individuals, the vast mass of the telephone trunk traffic must obviously emanate from and be for subscribers permanently connected with local exchanges; and accordingly the important problem which had to be solved was the working out of a system that would provide for establishing the most facile and rapid means of communication between the trunk circuits of the Postmaster-General and the subscribers to local exchanges, whether those of the Post Office itself or of the company. As the majority of the local exchanges are situated in the company's buildings, at a distance from the respective post offices, it would at first sight appear as though the concentration of the trunk circuits in the latter would introduce undesirable delay in manipulation; but on examination of the problem it becomes evident that this is not necessarily the case. At all large offices the separation of the trunk system from the local switch was long ago effected; and although the local subscribers' wires were generally multipled on the trunk switchboard, a subscriber's request for trunk line service was necessarily first communicated to the operator in charge of the local section, and, as it was impossible to arrange for every such local operator to have direct access to the trunk circuits, the request had to be conveyed by telephone to a recording operator, who first registered the want, after which the ticket containing the details was passed by a collector to the trunk operator in charge of the particular circuit wanted. Thus, whether, as was usually the case at the company's offices, the trunk switch was in the same room as the local switch, or, as occasionally happened, in an adjoining one, the same number of operations would be necessary in either case. Now, instead of the trunk switch being in the adjoining room, it is in another building in a neighbouring street, and, so far as the actual mode of transmitting information as to a subscriber's requirements is concerned, the operations are the same in number and character in both cases.

The general system adopted is as follows: All the trunk circuits are terminated at the respective post offices. Connection between the trunk and the local subscribers' switches is established by means of "junction circuits." For each trunk circuit one junction is provided to the local post office switch, and one to the company's principal exchange switch. These junctions are used solely for switching.

For conveying instructions, call or service circuits are established in the ratio of two circuits to each local switch for every 20 or less number of trunks. Half these circuits, known as "up" call circuits, connect the local switches with the recording tables, and they terminate in headgear telephones, which are worn continuously by the ticket operators. The other half, known as "down" call circuits, serve to connect successive groups of 20 trunk jacks direct with the switches of the local subscribers, and they likewise terminate in headgear telephones.

At the smaller offices, where a few trunk circuits only exist and the traffic is but slight, the call wires are fitted with indicators, and at the larger offices the call wires are terminated on indicators during the slack periods, as it would obviously be absurd to retain an operator listening continuously for a few intermittent calls.

The method of working is, briefly, as follows: A demand for a trunk call is conveyed to the local switch operator; the latter at

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once, without initiatory ring or signal, transmits the request to the recording operator, who enters the particulars on a ticket, which is then timed in telegraphic code and sent to the trunk section affected. It may thus be said that a local subscriber's want is immediately made known to the trunk operator at the neighbouring post office, although the actual time of putting through and the commencement of conversation depend, of course, on the number of prior calls, and the time lost in obtaining the distant subscriber's attention. When the call matures—*i.e.*, when the trunk circuit is free or previous calls have been disposed of—the trunk operators at each extremity come in on the "down" call circuits, and request the junction operators to join specified junctions through to the subscribers who are wanted. This done, the trunk operators then ring up the subscribers, and on receiving replies they connect them direct to the trunk circuit.

Stripped of all technicalities, the method of working is, briefly, as follows: A subscriber, say 100, in a town "A," wishes to communicate with one, No. 200, in a town "B." The former calls his local exchange, and expresses his wish to the local operator, then hangs up his telephone. This request is at once transmitted on the "up" call wire to the ticket operator at the post office, where it is recorded on a white numbered ticket, which is timed and placed on the trunk switch. In proper turn with others the ticket is dealt with thus: The trunk operator at "A" transmits the request to the trunk operator at "B," who enters details on a pink ticket. The "A" trunk operator then comes in circuit on the "down" call wire, and asks the junction operator to connect subscriber 100 to junction, say, 4, at the same time inserting the necessary pegs in junction 4 and in the trunk. The junction operator ascertains in the usual manner if the subscriber is disengaged, and, if so, she makes the necessary connection, advising the Post Office operator of the fact on the selected junction circuit. The latter then rings up subscriber 100, and tells him he is through to 200. At the same time the trunk operator at "B" is getting through to and calling 200 in a similar manner, and when both subscribers answer their calls they find themselves in communication with one another. Although the detailed description of the operations may appear complicated, the facilities for communication between the trunk and the junction operators are such that the brief instructions that are necessary are conveyed in a few seconds, and the loss of time in manipulation by skilled operators is insignificant.

The above describes the ideal condition of things. Unfortunately in many cases subscribers fix their telephones in out-of-the-way localities, and leave them in charge of office boys, who frequently regard them as toys rather than as a serious means of effecting important correspondence. In these cases the attention given is often bad, much time is wasted in ringing even before an answer is obtained, and more time is lost in fetching a responsible person to the instrument to deal with the matter in hand. In the meantime one of the subscribers is probably standing at his telephone unconscious of the cause of the delay, but anathematising the Post Office, the Telephone Company, and all connected therewith, and not unfrequently he concludes with a series of bitter complaints addressed to the local Press.

The obvious remedy for this undesirable state of things is for firms who have a considerable amount of telephone correspondence to provide two or more local connections, one of which should be rigidly reserved for trunk work. The telephone in connection with the latter should be fitted in the office of a responsible member of the firm.

In designing the apparatus necessary for working the Department's trunk circuits in accordance with the foregoing principles innumerable matters of detail had necessarily to be considered, amongst the more important being the following: (1) The capacity of the separate sections of a trunk switch, and the provision for growth and extension at each office; (2) the working capacity of the operators—*i.e.*, the number of trunk circuits each could manipulate satisfactorily and without delay during the busiest periods of a working day; (3) the signalling and calling arrangements both for trunk and junction circuits; (4) facilities for through trunking—*i.e.*, connecting two or more trunk circuits at intermediate offices to provide communication between towns not directly connected; (5) general details of switch and transfer on through trunking sections.

1. *Capacity of Sections.*—In dealing with this branch of the subject, requirements of very wide diversity had to be provided for, ranging from cases of offices with a single trunk circuit only to those with 200 or more circuits. Again, the growth of the system, which in certain localities will unquestionably be rapid, had to be considered, and it was obviously desirable to adopt arrangements of such a character that even in the case of abnormal increase there would be no necessity for any material modification of the apparatus already joined up. To meet these requirements it was determined to adopt as a unit a section complete in itself, containing all the necessary jacks, cords, indicators, keys, etc., for a certain number of trunks, and to provide as many of these sections as were needed at each office. Each such section is of such a size as to provide space and work for one operator in busy times, although in slack periods the whole of the apparatus on three sections is within the reach of and can be worked by a single individual. Thus, an office with one or two trunk circuits is fitted with one section, and, briefly, as many sections as are necessary to provide for the existing number of trunks and for a reasonable growth are fitted up to start with. Subsequent growth is met by the addition of the requisite number of sections without serious modifications of the existing ones; a mere redistribution of the position of the circuits to facilitate the traffic, together with the undermentioned slight alterations in the case of minor offices, being all that is necessary. Although switch sections of uniform size and pattern have been adopted, the requirements at the smaller offices are, of course, not exactly of the same character as at the larger ones, therefore three types have been provided, respectively known as "A," "B," and "C" sections. Small offices with less than three trunks are provided with an "A" section, offices with from three to 10 trunks are fitted with "B" sections, offices with more than 10 trunks with "C" sections. These sections differ only in the minor details of the arrangement of junction circuits, the presence or absence of transfer circuits, referred to later on, and other small points. The principle of working is the same throughout, and, if the ultimate growth of the system at an office renders it desirable to substitute a "B" for an "A," or a "C" for a "B" section, the removal of the existing section is not necessary, but the conversion can be readily effected *in situ* by withdrawing certain movable ebonite slip holders fitted with one class of apparatus and substituting others.

2. The number of trunk circuits on each section is practically determined by the manipulating capacity of an average trunk operator. If the latter be unduly burdened with work, delays arise in establishing communication, the idle periods on each trunk during busy hours become serious, more circuits are necessary for the transaction of business than would otherwise be required, and, as a consequence, there is a waste of capital and of maintenance charges. On the other hand, if the trunks are overstaffed, loss arises in clerical wages. The latter is, perhaps, the less serious item of the two, more especially when long and costly trunk circuits are in question. As the result of the general experience of telephonic working in this country, and after careful consideration of the whole question, it was concluded that, as an average, a fairly skilled operator should work five trunk circuits with facility and without delay. Accordingly the unit section was designed to accommodate this number.

3. *Signalling, etc.*—In the very earliest days of telephone exchange working Mr. Preece introduced an automatic system of signalling, which was so designed that the mere act of removing a telephone from its support announced a call by the dropping of a shutter in the exchange, whilst the restoration of the telephone to its normal position caused a current to be sent to the exchange which indicated, by a visible signal, the completion of the conversation, and the necessity for withdrawing the connecting pegs and restoring the shutter. This system became general in all post office exchanges, both on local and in a modified form on trunk circuits. In ordinary methods of open circuit trunk working the switch operator first inserts a peg in the trunk jack, then rings up her correspondent by means of a separate key or press button. The reverse operations are repeated at the close of the transactions, and if several trunks are connected at intermediate points these operations have to be repeated on each trunk. With an automatic system of signalling the insertion of the peg indicates a call at the distant office, and its withdrawal indicates the close of the transaction. These signals are automatically repeated through any number of independent trunks which for the time being may be joined up to form one circuit. The conventional signals which have been adopted by the Department are the following:

Indicator needle to the right	Line disengaged.
" " " left	Calling.
" " vertical	Line engaged.

The line indicator is a combination of a polarised relay, the electromagnets of which are placed horizontally, with an indicator needle in front of the poles. Normally, when the switch is fully manned, the traffic is regulated by the movements of the indicator needle alone, but for slack periods and at night the relay is brought into use to repeat calling signals through a local circuit by means of a bell or a buzzer. These bells are cut out of circuit by suitable switches during the day. The manner in which the signals are transmitted is illustrated in Fig. 11. It will be observed that in its idle position the line terminates on the indicator relay, in circuit with which is a battery of six cells known as the "permanent current line battery." A second battery of three cells, known as a "permanent current local," is joined up through a 350-ohm resistance and through the right-hand half of the relay electromagnet in such a manner as under certain conditions to reverse the polarity established by the line battery. The distant end of the line being terminated in a similar manner, the two positive poles of the respective line batteries are normally connected to the "A" line, and the two negative poles through relays to the "B"

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line; thus, if the insulation is reasonably high, no current flows from either end, and these batteries have no effect on the relay indicators. On the other hand, the local permanent current batteries send currents through the right-hand half of each relay electromagnet, the effect being to deflect each indicator needle to the right. If the distant operator now inserts a peg, she disconnects her indicator relay with its opposing batteries, and substitutes the

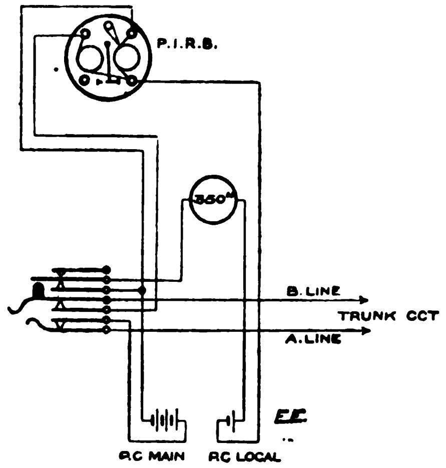

Fig. 11.

resistance of her local apparatus alone. The permanent current line battery current at the near end then flows with a reduced E.M.F. due to the effect of the local battery, but in the opposite direction to the local current through the right-hand coil, and with the added E.M.F. of the local battery through the left-hand coil of the relay. The polarity of the electromagnet is reversed, and the needle deflected to the left. On the insertion of a peg in the home jack to respond to the call, that indicator

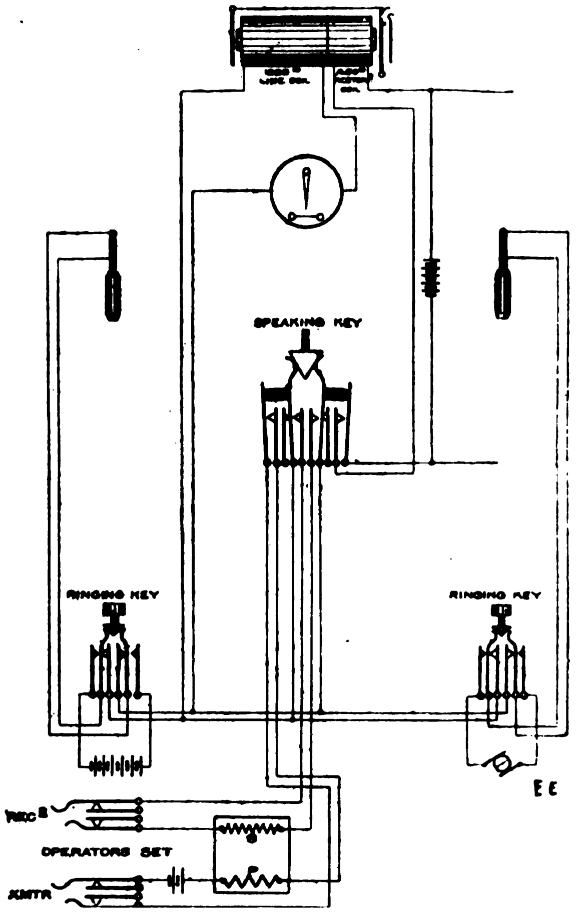

Fig. 12.

is also cut out of the line circuit, the local and line signalling batteries are disconnected, and the indicator needle becomes vertical. Ringing keys are likewise provided; one set, with black press buttons, being connected to batteries; the second set, with red press buttons, being joined to a small alternating dynamo, a pole changer, or a magneto ringer, according to the size of the office. The connections are illustrated in Fig. 12. The black keys are used for ringing up subscribers to Post Office exchanges, and for occasional use on the very long trunk circuits; the red keys for calling up the National Company's exchanges and subscribers. Separate indicators are provided in the switch cords to announce the completion of the conversation or the "ring off." There are two of these joined in series and bridged across each pair of cords, which form an electromagnetic shunt with a resistance of 2,000 ohms. Owing to the self-induction of these shunts, they act as choking coils to the rapid vibrations of the microphone, whilst responding readily to permanent currents or slow alternations. One of the indicators is a simple form of galvanometer designed to repeat the automatic signals in use on the Department system, the second a Western electric self-restoring indicator to respond to the magneto "ring off" of the company subscribers. When a Post Office subscriber is using a trunk circuit, and on the completion of his conversation, the restoration of the telephones to their supports sends a permanent current to the exchange. This deflects the galvanometer needle described above. The exchange operators at both ends withdraw the pegs, and if only one trunk circuit is in use the indicator relays, which are now brought into circuit, are both deflected to the right. If several minor trunks have been joined through at various intermediate points the line permanent currents from the terminal offices deflect the needles of the telephone galvanometers at the intermediate points where connections have been

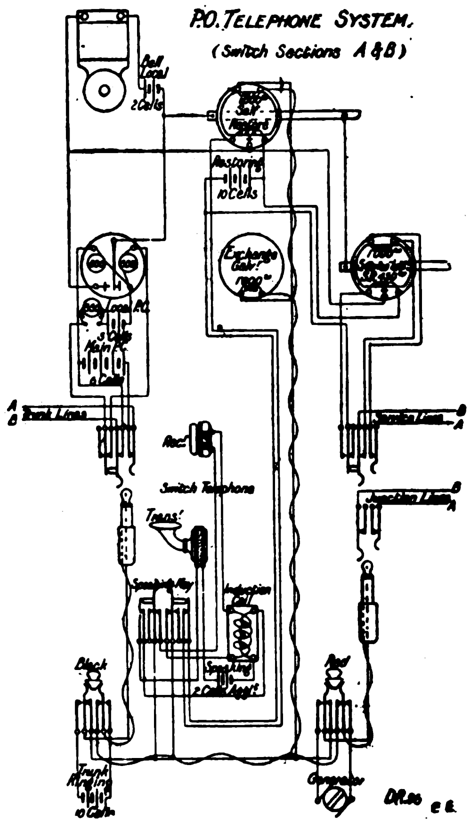

Fig. 13.

effected. The operators, without further enquiry, withdraw the pegs, and the normal condition of things is restored. When a trunk is in use by a subscriber to the National Telephone Company the operators are dependent on the business-like aptitude, or otherwise, of the subscribers for the "ring off." Should the latter fail to give the requisite turn of the handle to his magneto ringer the Post Office operators have to come into circuit at the expiration of the allotted period to enquire if the conversation is finished before withdrawing the pegs. Should a prompt reply not be given to an automatic call on a trunk circuit the black keys can be brought into use to obtain attention. Fig. 13 illustrates the connections on an "A" or "B" section.

4. Communication between different sections in one office to admit of joining one trunk circuit through to another can be effected in several ways. The most simple method of dealing with the problem consists in providing direct junction wires between each section and all the others; and this plan has been adopted where the sections are four or less in number, or where through trunking will, from the nature of the traffic, be infrequent. At large offices, however, the number of junctions necessary for this system would be very considerable; and as in practice it would be necessary to limit this number, then each junction would have to be multiplied along all the sections. To work these would involve the following operations: (1) testing for the engaged signal; (2) ringing up the section wanted; (3) on receipt of reply, transmitting the demand; these operations in practice involving more or less delay.

To overcome these difficulties, a modification of the divided board arrangement was introduced, which is, briefly, as follows:

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A through trunking or transfer section, sufficient to meet the requirements of 50 trunks, is provided for each 10 ordinary sections. From each section three "down" junction wires bearing the number of the section, and lettered A^1, A^2, A^3, are carried to the transfer section, where they terminate in cords and pegs. Similarly, two "up" junctions, terminated on jacks numbered and lettered B^1, B^2, start from the transfer section to the respective switches, where they terminate in jacks. The transfer switch is fitted with a three-position key for each "A" junction: first position, normal; second position, speaking; third position, through; and both these and the jacks are provided with contacts which actuate small grid indicators, which have in practice received the somewhat inappropriate name of "visual indicators," through local circuits.

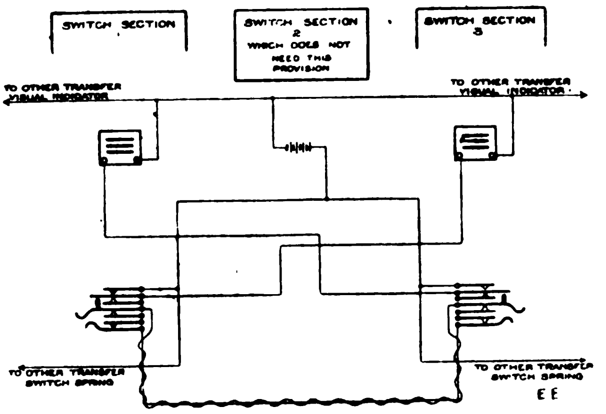

Fig. 14.

The method of working is, briefly, as follows: Glasgow requires communication with Cardiff, which at present would be obtained through Leeds. Glasgow calls Leeds, obtaining attention on, say, section 3, whilst the Cardiff trunk is, say, on section 14. The Leeds operator on section 3, on hearing the requirement, simply pegs Glasgow trunk through a disengaged "A" junction to the transfer switch, and this operation actuates a visual indicator on the junction at the l tter point. The operator at the transfer switch then turns

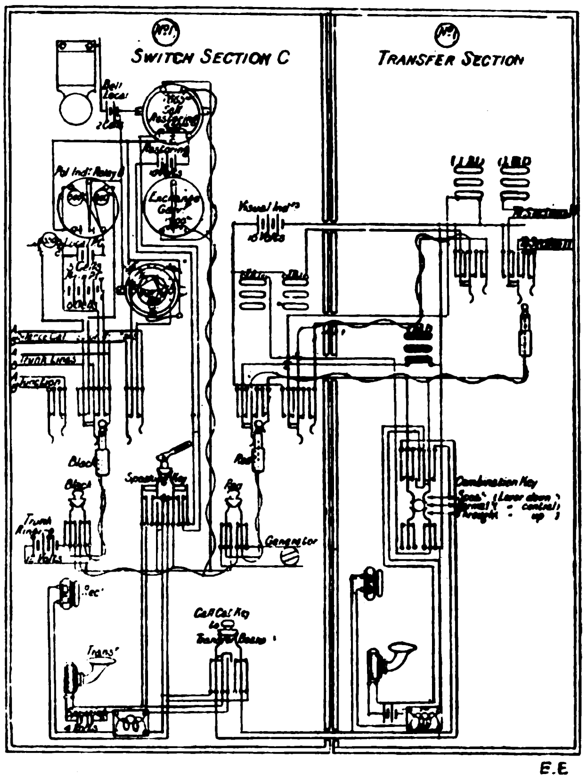

Fig. 15.

the key to "Speaking," and ascertains from Glasgow what is required, whilst the act of turning the key to "Speaking" drops a visual at section 3, which intimates to the operator at that section that the requirement is having attention. The transfer operator, on hearing that Cardiff trunk is wanted, pegs the "A" junction from section 3 into a "B" junction to section 14, thereby dropping a visual at the latter. The operator at this section, in pegging in a cord to reply, drops a visual at the transfer section corresponding to the "B" junction brought into use, which shows that the call is being attended to at the section on which the Cardiff trunks are terminated. The operator in charge of the latter then completes the connection. The talking is thus reduced to a minimum, being limited to two repetitions of the request for the Cardiff trunk, the automatic signals in all cases intimating to the operator who has pegged a trunk or a junction through that the next individual is attending to the call. None of these visuals are in the line circuit, but they are joined up on local circuits, and they remain depressed as long as the trunks are through. When the conversation is complete, this is indicated at sections 3 and 14 by the automatic signals from Glasgow and Cardiff respectively. The operators at these sections by withdrawing the pegs release the visuals at the transfer. The transfer operator on observing this withdraws the connecting peg and restores the speaking key to "Normal," which also releases the visual of switches 3 and 14. The connections for direct junctions connecting limited number of sections in small offices are shown in Fig. 14, whilst Fig. 15 illustrates the transfer-board working.

5. The general details have been partially illustrated by the preceding figures. Actual switch and transfer sections have been joined up in this room, and can be inspected at the close of the meeting. The system of duplex working that has been

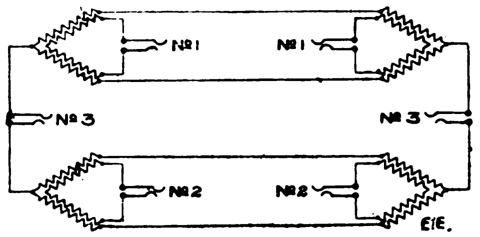

Fig. 16.

used by the National Telephone Company for some time has been adopted by the Department. Fig. 16 gives a diagrammatic sketch of the method of joining up. In this it will be observed that differential transformers are used, the secondaries being accurately balanced both for resistance and self-induction before they leave the workshop. No variable resistances are inserted, as any attempt to adjust in order to compensate for variations in the line would probably be a perfectly hopeless task. Under these conditions circuits of moderate length work satisfactorily, no ordinary changes in insulation resistance causing an upset of the duplex working so long as each of the arms is in sufficiently good order to work efficiently as a simple circuit. It is found, however, that if the circuits exceed a certain length it is difficult to maintain satisfactory duplex working; so that, for the present, this method is not applied to any exceeding 50 miles in length.

In the preceding remarks an endeavour has been made to describe succinctly the system of working adopted by the Post Office for its trunk lines. Of course these arrangements are not final, and already modifications are under consideration which have in view tbe facilitating of the switching operations by the further substitution of automatic signalling for verbal instructions on the junctions connecting the National Company's exchanges with the post offices. The growth of the system itself is progressing by leaps and bounds, and although trunk telephony is but of modern growth, and has in the past served rather as an adjunct to the ordinary methods of telegraphing, the time is rapidly approaching when it will rival the older methods in the extent of the plant, and in the importance, if not in the number, of daily transactions.

Discussion.

The **President** (Dr. Hopkinson) said that Mr. Gavey had given them a most valuable and interesting paper. The details of the system which had been explained to them had required the working of more than one brain for their development. Mr. Gavey's paper was one of a kind that the Institution wanted, as it gave them information which they had no means of otherwise obtaining. He might add that the earlier part of the paper had thrown great light upon the scientific part of the work and the theoretical questions which underlay it. There would, he thought, be time for only one speaker that evening.

Mr. Dane Sinclair wished Mr. Gavey had given him more chance of quarrelling with his paper. If he said what he thought about it, it would be that he wished he (Mr. Sinclair) could have written it himself. For those who were not telephone men the interest would lie in the first part of the paper. He was quite in agreement with Mr. Gavey in his exposition of those matters. He remembered the time when they sat and listened to induction and said it was heavy rain at the other end of the line. In order to deal with the problems before them it was necessary to get at the facts in the way that had been done by the author. As to duplex telephone lines, he believed that whatever might be the case with other branches of telephony, in that branch Great Britain was in advance of other countries. He had recently been in Stockholm and Copenhagen and seen what was done there, and he thought that the arrangements that had been shown them that evening would be beyond criticism by anyone who came from Scandinavia.

The discussion was then adjourned to next Thursday.

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TRACK CONSTRUCTION.

The advent of electric traction has vastly improved the service on those tramlines on which it has been adopted. The ease with which estimates of the power required by the car can be obtained when electricity is employed has also tended toward improvements in the permanent way. As in America they have had more extended application of electric traction than in this country, many new methods of track construction have been exploited there. Mr. M. K. Bowen, in his recent paper before the American Street Railway Association, gives some details of his practical experience in track work. He refers shortly to the sections of wheels and rails, and shows how inadequate the bevel on tramway wheels is to prevent slipping on the sharp curves used in street work. To prevent slipping as a car is going round a 50ft. radius curve, a bevel of about 1¾in. on a 30in. wheel would be required. Still, the present bevelling is of service when running on easy curves and on straight portions of the track. The author afterwards gives particulars of his experience with a cast welded joint between rail sections. He looks upon the joint as ordinarily made as the weak spot in track construction, and as causing the greatest amount of depreciation both in the wheels and track. In the cast welded joint the ends of the two rails are scraped and brightened, and a cast-iron mould is then placed round the joint. The molten iron consists of 25 per cent. of scrap, 25 per cent. of soft and 50 per cent. of hard silicon pig. The contraction of the metal makes a solid joint, and it is stated that amalgamation usually takes place. Still, bonding is usually adopted to ensure a metallic return. As will be readily understood, this method gives a practically continuous rail, and hence is open to objection on the ground of the strains set up by variations of temperature. Thus on one particular line some one hundred and fifty-four joints out of seventeen hundred were broken in one frost. The failure was readily seen, as the contraction of a considerable length is relieved at the broken joint. A space of three inches often is found between the adjacent rails at the break. The enormous tensional stress set up has been sufficient to tear a rail in two when great strength has been given to the joints. The greatest trouble is likely to occur at the curves, which both in extreme hot and extreme cold weather will be distorted. In spite of the care taken to make the joints while the rails are at a mean temperature, such troubles have regularly occurred. We do not, in spite of Mr. Bowen's approval, see any prospect of the introduction into our English practice of this system of rail jointing, which in cases has pulled in two a ninety-four pound rail. The author proceeds in his paper to consider the vexed question of how bad a track must be before reconstruction. The question of the large additional expenditure to be undertaken often causes the change to be deferred. The common-sense view of the subject is that of how much power is being wasted by running cars over a bad track. This, in a special case quoted, showed that, assuming a twelve-year life for the new

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track, the cost of the power saved would repay the outlay and interest on nearly five times the actual cost of reconstruction. When converting many of the old horse tramlines for electric working, the reconstruction of the track will repay for extra outlay. The English practice of providing good concrete foundations for the rails will mitigate some of the faults due to the joint. A better method than the cast welded joint for finally preventing wear at these places is that adopted by Messrs. Siemens and Halske in the line through the Thiergarten, Berlin. In this case each rail is built up in two longitudinal sections arranged to break joint. The joint between rails of each section is also made by dovetailing the two parts. This method provides for changes of temperature, and is eminently more in accord with the best engineering practice.

INVENTION v. DESIGN.

The great rush for electrical inventions in the early days of electric light has practically subsided, and large sums are no longer given for crude ideas backed by a blue book. Still, amongst the rising engineers the idea of inventing has a great attraction, as is shown by the numerous patents issued each year. It is said that every electrical engineer who makes a position for himself at some time or other must invent an improved arc lamp, a commutatorless dynamo, or a new switch. The expectation of making large royalties from these inventions cannot be realised in the face of competition with existing types, and yet the stream of invention continues to pour into the Patent Office. The original thought exercised in producing some of them is worthy of every commendation, although the conclusions have generally been forestalled by earlier workers in the same direction. The inventors either have not the convenience or do not trouble to look up the previous patents, and often claim existing types as entirely new. The great opening in the present state of the electrical industry is for design rather than new invention. The man who can design machinery in such a way as to save 5 per cent. in the cost of materials or labour is always valuable. He must be versed in detail and capable of readily grasping the commercial details of the subject. The question of commercial efficiency also comes largely into the design, and the manufacturers who can maintain the reputation of their apparatus for smooth working and durability are sure to succeed. Hence, while striking departures from existing practice may bring success to one man, two others will make fortunes by being able to get the best results at the least cost from everyday types.

THAT MEMORIAL.

We have purposely refrained from taking any active part in this controversy; but in consideration of a contribution which appears elsewhere, we may venture to express the opinion that no one has a right to dissent to a personal memorial being arranged, though many will claim a right to dissent when the memorial is of a character to indicate scientific representativeness. The gentlemen in whose memory a memorial is considered necessary filled a particular niche in commercial economy, but had no claims to scientific attainments, nor did they ever venture, so far as we know, to put forward such claims.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

MACDONALD'S RELAY.

SIR,—With regard to a notice of my relay in your issue of July 31, 1896, my agent writes: "Perhaps if you were to write to the editor the errors in this paragraph would be exposed . . . Evidently the American and English Press has taken considerable notice of your relay." I esteem it an honour to be noticed for what is only an improvement of the Morse relay. Your paragraph implies a total misconception of what that improvement is. I shall deem it an especial favour if you will correct the erroneous impression it has caused. First, then, two springs are not used. The thought occurred, and also its limitations, which, to one practiced in the use of the Morse relay, are readily perceived. Perhaps the best thing to do will be to give you a succinct account of my purpose in this invention and the manner in which the purpose was effected.

First, then, I supposed that the armature was not as free *mechanically* as it might be made. A cursory consideration of the matter showed that this supposition was well grounded. I took a relay, American pattern, wound to 144 ohms, and got working on the finest possible adjustment through 780 ohms extra, with one Leclanché cell. This was the ordinary instrument in the ordinary state. I tilted this relay, nothing more, and got working through 1,400 ohms, when its cores were vertically placed. The *armature* was then horizontal, and so moved more freely. There was no *vis inertia* about the armature then as compared with it in its former poise.

Next, I put a balance weight on the end of the armature away from the contact points (see British patent 20,886, October 31, 1894; French 242,533, October 31, 1894; American 551,192, December 10, 1895; also Canadian, Indian, and Colonial—all full patents). This rendered the relay still more free at its armature, and also ensured a firm contact all the time. I wondered at this, but it was due to the balance being on the free end and opposite to the contact points, so that when the armature swung down on to the contact the balance flew up, and by its centrifugal force increased the contact pressure at the opposite end. You have to see this to understand the gain that ensuring perfect contact makes to a telegraphist. But this was not all.

Thirdly, I proportioned the retractile spring—one only being used—so accurately to the difference in force of attraction of armature to core when pulled down and of attraction of armature to core when held back, that with the simple relay described, *total* resistance only 144 ohms of ordinary relay wire—*i.e.*, 72 ohms each leg—I worked on a *line* through 6,200 ohms external resistance with only one Leclanché cell (No. 2, I think), and old voltage, say, 1·3. Of course this was not the limit of its power, and only the usual care required in adjusting a relay to best advantage was used, but the attracted parts and contacts were close. Relays wound with a greater number of turns of wire I have found give proportionately better results. Adjustment was effected by retractile *spring alone* for any variation of current from 35 milliamperes to one-fifth of a milliampere. Having the balance in a horizontal position, I weighed in grains and parts of a grain the attractive force of the armature and core for various strengths of current. My patent mentions one grain, but, as a matter of fact, a relay set as described readily responds to very much less weight. The effect of a momentary moderate current in increasing magnetic sensibility is an interesting item, but I

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have already been too prolix. This increased sensibility lasts for several days.

I shall be very glad if you will make such corrections as are needful. When made, kindly post me copy of your journal, as I am far from city life. You will greatly oblige—Yours, etc., A. D. MacDonald.

Telegraph Office, Hamilton, Victoria, Australia, October, 12, 1896.

OBITUARY.

WILLIAM JAMES TYLER.

With feelings of deep regret we have to announce that on Friday, 13th inst., there passed away, at his residence in Blackheath, Mr. W. J. Tyler, the much-esteemed secretary of the India Rubber, Gutta Percha, and Telegraph Works Company, of Silvertown. Mr. Tyler had been in failing health for some time, but the end came as a surprise to most of us. The deceased was much liked and respected by those who had the advantage of his acquaintance. In 1870-71, Mr. Tyler served with those who went to aid the wounded during the Franco-German War, and here he won the regard of all his fellow-workers in this excellent cause, including Sir Henry Brackenbury, Sir Vincent Barrington, Sir William MacCormac, and Mr. Archibald Forbes, the famous *Daily News* war correspondent of that fearful campaign. On the retirement of Mr. G. A. Brand, late in 1871, our lamented friend was appointed to the secretaryship of the Silvertown Company, which responsible and prominent position he held, with much credit and dignity to this firm, up till the time of his death. In 1872 he represented his company in the colonies of the Cape of Good Hope in endeavouring to bring about the establishment of submarine telegraphic communication to the Cape by the East Coast of Africa. His arduous work (which involved loss of health) did not, however, bear fruit until some years later in the Eastern and South African Telegraph Company's cable system, which, as we know, has proved a complete success ever since its lines were laid.

It is the man rather than his useful work that we like best to look back upon and remember. The deceased was one of those who would have done well, to the best of his ability, whatever he turned his hand to. His courtly manner would, perhaps, have been turned to more useful account in the service of diplomacy than in the city of London. Chance did not decree this, however, and thus it is that we have had the advantage of experiencing that extreme courtesy and thoughtfulness (towards all alike) which was so strong a feature in his character.

Much good that Mr. Tyler has done as an energetic Churchman with a strong sense of humanity will probably never be heard of. We may rest assured, however, that his memory will be sacred to all those who have known him. Anyone more accurately carrying out the true meaning of the word gentleman it is difficult to imagine. It was but in his sixty-first year that the deceased left us, much to our loss. He was a good and kind friend to many, and one for whom and with whom it could not fail to be a pleasure to be associated with in business or in work of any description. A man of his modest and retiring nature (living for others rather than himself) shines more in his own family circle that in public. This is, perhaps, the highest praise that can be bestowed on anyone, and it seems to us it really applies in this instance. Finally, we wish to tender our deep sense of sympathy to those of his family he has left behind, and especially to his widow. We also desire to do so to the Silvertown Company and his fellow-workers, who must, indeed, sorely miss him. Many friends gathered at his grave at Charlton Cemetery on Tuesday last to pay their last respects to his memory on the occasion of the funeral.

Belgrade.—Tenders will be received on November 27 for an electric lighting installation at the National Theatre at Belgrade. Application is to the Servian Ministry of Public Works, Belgrade.

THE HUTIN-LEBLANC FLYWHEEL ALTERNATOR.

A large 600-kilowatt alternator of the above type has recently been delivered by the firm of J. Farcot, of Saint-Ouen, to the electric light company in the Champs-Elysées district in Paris. The plant previously installed in the station consisted of three 400-kilowatt Hillairet alternators driven by Farcot engines. It is stated in *L'Industrie Electrique*, from which paper we cull the following details, that the power factor of this station at full load is only ·8, and hence that when the alternators were given the full current the engines had only to provide 80 per cent. of their rated power. We do not understand why this full-load power factor should

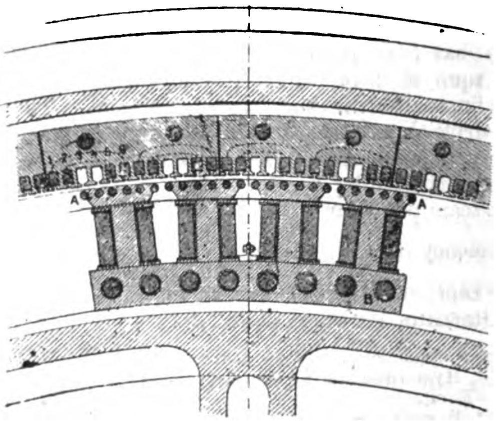

Fig. 1.

be so low, but from it the new alternator has been designed to give 600 kilowatts apparent output, corresponding to 480 kilowatts actual power. The current, 200 amperes, is generated at 3,000 volts, and the frequency of supply is 40 ∼ per second. The speed of the engine is 60 revolutions per minute. The sections of the machine (Figs. 1 and 2) will enable the reader to follow the description. The iron of the armature is built up in laminated blocks, having six recesses in the space opposite one pole. The form of these recesses can be seen in Fig. 1. The idle spaces not used for winding tend to keep an approximately uniform magnetic resistance. The armature circuit consists of 80 coils, wound flat and connected in two parallel circuits. Each coil consists

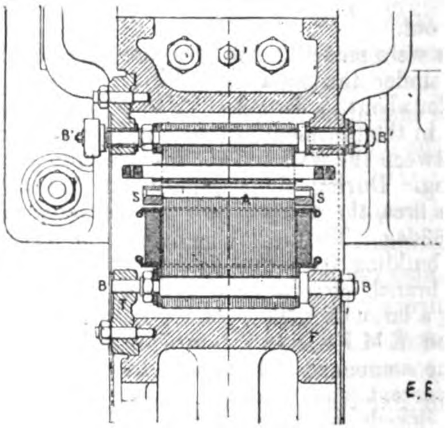

Fig. 2.

of two concentric windings, each containing 12 turns of wire of ·05 square inch sectional area. The wires are insulated by micanite, which gives a very high insulation resistance between the circuit and the iron of the armature. This iron circuit is built up of 40 blocks, each carrying two armature coils, and the blocks are insulated from each other by ebonite ·120in. thick. The bolts, B' B' (Fig. 2), which support the block are insulated by ebonite, both from the laminated iron and from the cast-iron frame of the alternator. This insulation tends to prevent discharges to the frame due to the capacity of the line. The air-gap is only ·31in. The external diameter of the

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armature is 23ft. 6in., and its breadth is 2ft. 1in. In this machine the magnets are the moving parts, and are attached to the flywheel of the engine. The magnetic system is formed of 80 poles, built up of sheet iron 78 mils thick fixed to the wheel by two bolts, B B. These are clamped to a rim of the flywheel at one side (Fig. 2), and on the other rest in movable segments, T. There are 20 of these movable segments, each of which secures four poles. The magnets are wound with wire ·021 square inch section, connected in four parallel circuits. The polar projections are also provided with six grooves to receive six copper bars of ·82 square inch section, which are riveted at both ends into copper segments extending over four poles. These bars form practically a squirrel cage, and reduce fluctuations of the magnetic flux. The external diameter of the magnets is about 19ft. 7in. The machine is excited by a 40-kilowatt direct-current dynamo at 220 volts. This machine has four poles, and has in its polar surfaces a similar squirrel cage. This precaution is also used to prevent fluctuations in the exciting current. The engine used to drive this alternator is of the single-cylinder Corliss-Farcot type, condensing. The diameter of the piston is 31½in., and the stroke 4ft. 7in. The guaranteed consumption of steam per hour is 14½lb. per indicated horse-power. The efficiency of the set—*i.e.*, $\frac{\text{E.H.P.}}{\text{I.H.P.}}$—is found to be 83·5 per cent. at full load.

The alternator losses are as follows :

Armature—Copper loss	17,000	watts.
Hysteresis and Foucaults	7,500	,,
Magnets—Excitation	12,000	,,
Damping coils	6,500	,,
	43,000	,,

This, at an output of 480 kilowatts, gives an electrical efficiency of 91·8 per cent.

TEST OF AN ISOLATED ELECTRIC LIGHTING PLANT.*

BY S. A. BEYLAND.

This article contains the results of tests of the gas-engine and lighting plant belonging to the First M. E. Church, of Knoxville, and was made in order to ascertain the economy of such a plant in actual service as run by the janitor. No precautions were taken to have the machinery in better order than usual, and the gas was measured by the regular meter furnished by the gas company, by which the bills were made out.

The tests were made by the engineering students of the university under the supervision of Dr. Perkins. They continued for about three hours. The engine and dynamo are located in the basement of the church, and in a cramped position between the wall and the furnace used for heating the building. During these experiments, on account of starting the fires, the temperature of the room rose from 60deg. to 82deg. The switchboard was on the opposite side of the building from the dynamo, on the main floor, and all the branch circuits were fed from this point, thus introducing a large drop in pressure, as mentioned below. Current and E.M.F. were measured by Weston instruments. The ammeter read only to 50 amperes. Above that point current was reckoned by the number of lamps in circuit. Speeds were measured by a tachometer, and quantities of gas by the meter in regular use furnished by the gas company.

The engine was the regular Otto 10-h.p. machine, fitted with a governor controlling the speed by regulating the number of explosions. This governor worked well at high loads, but at very light loads the speed would frequently drop five revolutions or more below normal before an explosion would occur. The dynamo was rated at 110 volts and 60 amperes. It was compound wound, and the characteristic is shown in Fig. 1. For further regulation a rheostat is placed in the shunt field coils, which is cut out at high loads in order to compensate for the excessive losses in the feeders. The dynamo was run at a speed of about 1,550 revolutions per minute. During the course of the test additional lamps were thrown on until the current rose to 70 amperes, while the temperature of commutator increased from 60deg. to 122deg., the temperature of the room increasing during the same time to 82deg., as above mentioned. With a current of 50 amperes a drop of 7·7 volts was noted between dynamo and switchboard, indicating a resistance of about 15 ohms. The wire was evidently too small, causing a loss of 1 per cent. for 10 lamps, 5 per cent. for 50 lamps, and 10 per cent. for 100 lamps. The loss in branch circuits was also quite large, but was not determined, the lamps in the main chandeliers being inaccessible. The lamps used required about 80 watts, or 5 watts per candle-power if we take them at their rated (16) candle-power.

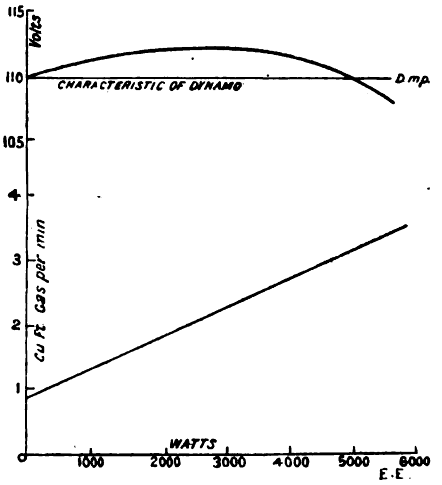

Fig. 1.

The consumption of gas above that necessary to run the engine and dynamo unloaded increased quite uniformly with the load. The accompanying figures show the cost of lighting per hour of actual plant for different loads, also cost for same plant if four-watt lamps or three-watt lamps were used. Lines are also drawn showing the cost of the same illumination using gas, the gas being taken at 20 c.p. as given by the regular tests of the gas company. The gas is reckoned 1dol. (4s. 2d.) per 1,000 cubic feet, and at 1½dol. (6s. 3d.) per 1,000 because the local company charges the latter price for gas used for illumination, while for gas-engines and all fuel consumption they charge 1dol.

The illustration (Fig. 2) shows the cost per hour in cents, and the price of gas in dollars.

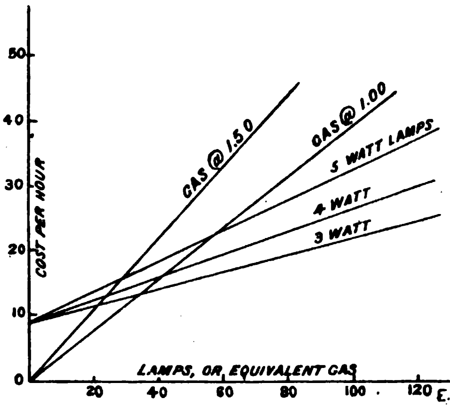

Fig. 2.

From a consideration of the figure it will be seen that where only a small number of lights is required gas used directly is much cheaper. Above 30 lamps it is decidedly cheaper to use the gas for fuel in driving the dynamo. Thus if it is desired to illuminate but one or two of the smaller rooms the gas-burners are used, but if the main audience-room or the entire building is to be lighted the dynamo is put in operation.

* From the *University Scientific Magazine.*

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Number of lamps.	External			Cubic ft. gas per min.	Gas per lamp hour.	Gas per watt-hour.	Gas per 64 watt-hours.
	E	I	W				
Engine with no load				1·25	—	—	—
Belted to dynamo—no current				1·54	—	—	—
3	110·5	2·13	225	1·82	27 2	·485	31·0
31	112	22·6	2,531	2·83	5·3	067	4·23
51	112	38·0	4,256	3·61	4·16	·051	3·26
71	110	(51·8)	5.702	4·29	3·57	·045	2 88
67	110	49·0	5,390	4 17	3·68	·046	2·94
80 {	108	—	6,296	4·35	—	—	—
	Change in rheostat shunt coil.				—	—	—
	110	58 3	6,471	4 84	3·58	·044	2·86
98	110	71·3	7,843	5·36	3·25	·041	2·52

Current in shunt coil, 1·35 amperes; loss, 1·43 watts; drop to switchboard with 70 lamps at 50 amperes, 7·7 volts; loss, 385 watts, or 17·3 cubic feet of gas per hour.

THE INSTITUTION PAPERS.

A cry has been raised for a change of intent,
A slur has been cast upon efforts foregone;
And if ink has been wasted, if time has been spent,
To the purpose of nothing—go, spread the cry on!

The sting of the cry and the knob of the slur
Are directed at certain MM.I.E.E.;
And, if one is an unit and two are a pair,
Then names and intentions are easy to see.

Produce the *Proceedings* and turn the leaves o'er;
Most papers are useful, most authors renowned;
Small blame to the scribe if behind and before,
And perchance in the middle the Morals are found.

The Morals that deal with the author's machine,
The Morals that point out defects in the rest,
The Morals whose meanings are plain to be seen,
Regarding devices, and which is the best.

But sandwiched between, like the thorns and the bud,
And scattered about like the plums in the duff,
The data and useful experience should
Atone for the rest of the innocent "puff."

* * * * * *

When a change has been wrought in the nature of man,
When the *Ego* is not but the *Tu-toi* remains,
Then papers will read on a different plan,
The products of virtue, as well as of brains.

But while the Old Adam is still in each heart,
We'll take and be thankful for what we can find;
And store up the "tips" that the papers impart,
And leave all the Morals for those who are blind.

November 17, 1896. J. H. C. B.

ELECTRIC LIGHTING AT DARWEN.

REPORT BY MR. E. M. LACEY, A.M.I.C E.

On July 15 last you informed me that your Council had resolved to ask me to report as to lighting the town of Darwen with electricity, and in transmitting this resolution you stated that the Electric Lighting Committee would like me to show (1) the lighting area; (2) the capital cost of the works, and particulars; (3) the cost of machinery, and whether there would probably be a profit consequential upon the installation; (4) the utilisation of refuse destructors for steam-raising purposes in connection with the proposed electrical works.

Having satisfied myself that, for the proper consideration of the complex conditions associated with the investigation, an inspection would be necessary, I visited Darwen on August 21 and September 10, and after having placed myself in communication with Mr. Stubbs, the Corporation engineer, who kindly furnished me with certain local information and other necessary details, I again visited Darwen on September 21. Having since that date thoroughly considered the entire subject, I now beg to submit the following report thereon.

In order to place the matter before you in the clearest possible manner, I have considered it advisable to divide my report under five headings, as follows: (1) probable demand for current; (2) the most suitable system; (3) capital outlay necessary; (4) probable profit, after payment of interest and sinking fund on the capital expended; (5) the desirability of combining the electricity works with a system of refuse destructors.

Before dealing with the advisability of establishing corporation electricity works in your town I think it desirable to refer to the feeling which has influenced some municipal authorities to discountenance electric lighting, on the grounds of presumed injury to the gas properties which they own. This idea is purely imaginary, and it has been proved, not only in London, but also in many other towns, that with the adoption of electric lighting the gas demand for cooking and warming purposes has still increased to so great an extent as to more than balance any decrease for purposes of illumination.

Probable Current Demand.

Lighting.—I have been carefully over those portions of the town where a demand for a supply of current for lighting purposes is possible, and I find that in the event of electricity works being established, there would be an immediate demand for current in the following localities: Market-square, Railway-road, Church-street, Frederick-street, Bolton-road from the Market square to the cemetery, Duckworth-street, and Blackburn-road to Westwell-street. I estimate that, with current sold at the rate of 6d. per Board of Trade unit, the demand in these streets and their immediate vicinity should, during the first two years' working, amount to the equivalent of 6,000 lamps connected, and that the number of lamps connected at the end of three years, both in the above streets and in the remainder of the area, will amount to at least 11,000. This number will, of course, be increased as the charges for current are reduced, which reduction can be effected by the Corporation, owing to the greatly decreased cost of production.

Power.—From my investigations I do not anticipate there will be any considerable demand for power purposes during the first year, although there undoubtedly will be eventually an appreciable demand for small power motors, but this will not entail any further capital expenditure, as current required for power purposes being almost entirely during perids of light loads there would be no necessity to make any addition to the capacity of the generating plant.

Traction.—Several municipal authorities have recently entered into arrangements with tramway companies serving their districts for the supply of electricity for traction purposes, and a profitable arrangement for such supply might at any time be made in your town The economy and other advantages of electric traction for tramway work are now being fully recognised by the tramway companies, and any company working a tramway within the range of your provisional order would be unable to carry mains for current generated by themselves, provided that your Corporation were prepared to supply. At the same time it is an advantage for electricity works to supply current for traction purposes, as the generating plant can then be utilised at those periods of light load when it would otherwise be standing idle, thereby reducing the cost of production and increasing the efficiency of the works.

The Most Suitable System.

The System of Supply.—In arriving at a decision as to the most suitable system to be adopted, it must be remembered that there are now, in addition to the two original systems—viz., high-tension alternating, as at Bolton, and low tension direct, as at Bolton—several other simple or combined systems of supply which are at present working most satisfactorily. Amongst these may be mentioned high-tension direct current with sub-stations and low-tension network, as at Wolverhampton; low-tension five-wire direct current, as at Manchester; low-tension three-wire direct current (400 volts), as at St. Pancras extensions; direct current three-wire supply, combined with high-tension alternating supply for outlying districts, as at Blackburn. Any of the above systems might be the most suitable one for a proposed area of supply, and in selecting or designing a system, the conditions of the localities, the nature of the demand, and the area of supply have principally to be considered. The points which constitute the most satisfactory system are as follows: (1) low capital expenditure compared with capacity of supply; (2) immunity from breakdown and failures, and low annual expenditure for repairs and maintenance; (3) economy in the production of current, and its transmission to the consumers' premises; (4) the arrangement of the system of distribution, such that extensions both within the area and to outlying districts may be carried out on the most economical lines. In addition to the above points, it is most necessary in such a town as Darwen to provide only such generating plant as may be necessary for immediate use, but at the same time to so design the station that additions may be made from time to time without interfering with the original installation, or necessitating a cessation of supply. It is also desirable to design works which can be most economically adapted to the supply of current for power or traction purposes, provided this can be done without impairing the efficiency of the system. By designing the works on the above lines an enormous advantage may be subsequently obtained, since should power be supplied to the tramways in the future, an exceedingly small expenditure of capital would be entailed, and the cost of the production of additional current for power purposes would be reduced to a minimum.

The System Recommended.—Taking all the above points into consideration, the system which is most suitable, most reliable, and which would give the best results, both from an electrical and a commercial point of view, is a system of direct-current three-wire supply, with a difference of potential of 440 volts between the outer cables throughout the whole area, and a 220-volt service to the consumers. This system, if applied in your town, will comply in every way with the points enumerated above. The generating station, if properly designed, will allow of a low capital expenditure, and the plant can be such as to secure immunity

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from failure. The system of distribution will be such as to give the least possible loss in your particular area, and both the first cost and cost of future extensions will be exceptionally low if sufficient care be given to the initial arrangement. The annual works costs for current production will also be kept at a minimum, as the ease of regulation and the absence of transformers or of any complicated apparatus for maintaining the required pressure will enable the system to be worked with the least possible amount of skilled labour, and at the same time avoid the many consequent losses between generation and consumption. This system, besides being actually the most serviceable for lighting purposes in your town, also complies with the requirements of power and traction work, and the same plant can be designed, without additional cost, in such a manner that it is interchangeable for either traction or lighting purposes.

CAPITAL EXPENDITURE.

The Plant Necessary.—In order to provide for the adequate supply of current for the number of lamps connected during the first year as estimated above (6,000), generating plant would be required of a capacity of 120 kilowatts, but it would also be necessary with a first installation of plant to provide a duplicate generating set as a stand-by during cleaning or repairs. This spare set will be a sufficient stand-by until such time as an additional plant has been added to the equivalent of 18,000 lamps connected. It can therefore be seen that the cost of extensions will not be in the same proportion as the initial cost of the installation. To provide steam for the above plant a boiler of sufficient size is required, together with a duplicate boiler of the same capacity. The remarks applied to the duplicate generating machinery also apply to the boiler extensions. With this plant a balancing apparatus for the centre main and accumulators for storage purposes are required, together with main switchboard for the efficient regulation of the current supply. The above, together with all requisite steam, exhaust, water, and electrical connections, overhead travelling crane and engine-room accessories, are all that are necessary; but I have also included the cost of condensing plant, as the saving which will be effected by this will at present more than pay the interest and sinking fund on the increased capital expenditure, and with the future increased output will effect a very considerable saving.

The Site.—I have ascertained that a site for the works is available on the vacant property in the possession of the Corporation adjoining the technical schools. This site I have visited, and I find it most suitable for the purpose required and for the system recommended above.

Buildings.—The buildings should comprise engine and boiler house, chimney shaft, accumulator-room, test-rooms, stores, and offices, and these would be so designed as to facilitate extensions at the least possible cost. I estimate the cost of the works described above as follows:

Central Station, Frederick-street.

Buildings, inclusive of overhead traveller	£3,100
Two steam dynamos, each having an output of 120 kilowatts	3,200
Balancing apparatus, switchboard regulating gear, electrical connections, instruments, etc.	800
Accumulators	900
Two boilers, condensing apparatus, feed pumps, steam and exhaust pipes	1,900
Feeder and distributing mains, junction boxes, and all necessary street works	4,100
Service connection to consumers	900
	14,900
Contingencies, 5 per cent.	745
	£15,645

That this capital outlay is an exceptionally small one may be best demonstrated by a comparison with the cost of other electricity works in the neighbourhood. I therefore append the following costs of some of the smaller systems calculated on the basis of 6,000 lamps connected: Blackburn, £18,000; Bolton, £24,000; Burnley, £19,000; Bury, £19,000; Lancaster, £20,000; Preston, £32,000; and Southport, £22,000. In making this comparison I am placing the cost of your proposed system at considerable disadvantage, for, with the exception of Burnley and Bury, the above works have all a considerably greater number than 6,000 lamps connected, and therefore, as I have mentioned above, the outlay for spare plant is proportionately much lower. The works can be so designed that the additional cost of plant and mains for a further 6,000 lights would not exceed £6,100, or a total of, say, £22,000 for 12,000 lamps connected. Further extensions could be carried out on a slightly advanced ratio of cost.

PROBABLE PROFIT.

During the first year's working the cost of production and receipts should not be estimated on a higher basis than that of an average of 2,000 lamps connected for the whole year. During the second year of working I think I may safely calculate the profits on the basis of 5,000 lamps connected for the whole year. I also add the cost of production and receipts from an installation of 12,000 lights, which should be in the fourth year.

Probable Receipts and Expenditures at a Charge of 6d. per Unit.

	First year.	Second year.	When 12,000 lamps connected.
Average lamps connected	2,000	5,000	12,000
Estimated number of units sold	52,500	96,000	180,000
	£ s.	£	£
Receipts from sale of current	1,312 10	2,400	4,500
,, ,, meter rents, etc.	46 0	88	130
Total receipts	£1,358 10	£2,488	£4,630
	£ s.	£	£
Works costs—Coal	145 0	270	425
Engine-room stores	33 0	52	125
Salaries and wages	410 0	525	750
Repairs and maintenance	45 0	120	250
Rent, rates, taxes, etc.	80 0	100	200
	713 0	1,067	1,750
Interest and sinking fund on £15,600	780 0	780	1,100*
Total costs	£1,493 0	£1,847	£2,850

* Interest and sinking fund on £22,000.

These accounts show a deficit for the first year's working of £135 after payment of all capital charges; a net profit on the second year's working, after paying off first year's deficit (£135), of £406; and a profit when 12,000 lamps are connected of £1,780. The above figures on revenue and works costs are not theoretical calculations, but are based directly on the revenues obtained and the actual costs achieved at several electricity works which have been supplying current for from one to three years. As before mentioned, I have not taken into account current which may be supplied for power purposes, the receipts for which will add considerably to the profits of the undertaking, as no extra capital expenditure is necessary to meet this demand.

REFUSE DESTRUCTORS.

During recent years most exaggerated views have been advanced both by experts and others with regard to the immense savings to be effected by the utilisation of the products of the dustbin as fuel for steam raising in connection with the generation of electricity. By comparing the figures given above for cost of coal with the interest on capital expenditure and cost of upkeep of a system of refuse destructors, it can be seen at a glance that the refuse is actually the most expensive fuel. If, therefore, the question of electric lighting only were under consideration, and the town's refuse already being economically dealt with, I should be slow to advise the expenditure necessary for destructor works for the sake of the possible savings. In the case of Darwen, however, it is not so much a question of the advisability of destructor works as of the combination of these works with an electric lighting scheme, since I understand that it has already been decided that such works are practically necessary and will of themselves effect a saving on account of cartage, etc. Under these conditions there can be no doubt whatever as to the advisability of combining the two works. If this can be carried out on the site mentioned above, the saving effected will be very considerable, and even if it were found necessary to erect the destructor works at some distance from the centre of the town, it would still be of advantage to also transfer the electricity works, although this might require some alteration in the system proposed above and a possible increase in capital cost. The proposed site near the technical schools would enable the combined operations to be carried out in a singularly advantageous manner both on account of its central position and the formation of the ground. I might also add that in other more populous districts there has been little or no opposition to the establishment of electricity works consuming refuse, where there would undoubtedly have been considerable opposition to the erection of an ordinary refuse destructor. The advantages of combining the destructor and electricity works may be described as follows:

1. *Capital Expenditure.*—The first cost of destructor works to deal with the refuse of your town would be approximately £3,750. If these works were to be specially designed for combination with the electricity works, the additional cost of the destructor portion would be approximately £500, which would be more than balanced by the saving effected in the cost of buildings for the electricity portion and the utilisation of one chimney shaft for both purposes.

2 *Steam Raising.*—The steam power which could be obtained from the destructor boilers may be taken during winter load at about 200 h.p., and during summer at about 100 h p. It must not, however, be supposed that this power is available to its full extent for electric lighting purposes, this being impracticable owing to the fact that plant for electric lighting is working at heavy loads for only about four hours in the twenty-four, whereas, on the other hand, refuse is continually being delivered for from eight to ten hours, and must be dealt with almost at once. Even if destructors were designed to deal with the whole of the refuse during the period of heavy load, the fact that interest on capital expenditure would more than balance the value of the fuel saved renders such a scheme commercially impracticable. Storage either thermal or electrical is also too costly to be employed on a sufficiently large scale. I, however, estimate that the actual saving in fuel value effected by a combined scheme would be from £90 to £200 per annum as the output of the station increases. Should an arrangement, however, be entered into for the supply of power during the day for traction or other purposes, the generating station would then be provided with a continuous load, and the refuse could be utilised to its fullest extent.

3. *Working Cost.*—By combining under one staff both the destructor and the electrical portion of the works, the annual cost of management and labour for both undertakings could be considerably reduced.

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Taking the above facts into consideration, I am of opinion that, even putting on one side all question of future traction or power supply, the economies to be obtained by the combination of the electricity with the destructor works are such as to render the undertaking one that will prove of very considerable benefit.

SUMMARY.

I advise (1) that the area which may be profitably supplied at once includes the streets mentioned above and coloured red on the plan (this being the proposed compulsory area), and that the area which can be economically supplied is all that district coloured pink on the same plan; (2) that the system which will best meet the requirements of the area of supply is a direct-current three-wire 440-volt supply; (3) that works be erected and a system of distribution laid down at a cost of £15,645, this being sufficient for the supply of current to 6,000 lamps connected; (4) that the undertaking will yield a profit on the second year of working, and from that time forward will be an exceedingly profitable concern, even after allowing for a reduction in the current charges to consumers; (5) that since it is already decided that a refuse destructor is necessary for the town, a proper combination of such destructor with the proposed electricity works will very appreciably reduce the cost of the production of current, and the capital expenditure on the combined scheme will be less than that of both works if erected independently.

In conclusion, I would add that the prospects of making an electricity undertaking a financial success in Darwen are such that it will probably not be long before electricity works are established by private enterprise should the Corporation not take steps to obtain a provisional order and exercise their powers under it.

The following letter has also been forwarded by Mr. Lacey to the town clerk with reference to the proposed electricity works, Darwen:

Dear Sir,—You may remember that at the meeting which I attended on Thursday last I informed the committee that whilst not prepared to quote figures for other electricity works off-hand, I should be pleased to forward the Board of Trade returns for other towns where corporation electricity works are established.

By referring to my report you will see that for the first year's working I estimated an average number of 2,000 lamps connected throughout the whole year, this average representing 4,000 lamps connected at the end of the year. I give below my estimated figures for Darwen and the results obtained in various towns for the purpose of comparison. These figures are all taken from Board of Trade returns, and are for municipal works only. I have not given the results achieved by private companies, although these are in some cases even more satisfactory.

COMPARISON.

Town.	Lamps at end of year.	Units sold per lamp.	Total units	Price per unit. d.	Revenue. £	Total costs. £	Deficit. £	Surplus £
Darwen..	4,000	13	52,000	6	1,400	1,535	135	—
Nelson	4,500	16 26	64,981	5	1 281	1,025	—	256
Burnley	6,708	15 77	74,383	6	1,802	1,932	131	—
Lancaster......	6,312	15·05	78,264	5	1,612	1,918	306	—
Hanley	11,930	16·80	180,469	6	3,512	3,441	—	71
Oldham.........	6 940	16·99	68 988	6	1,775	1,927	152	—

The above figures will, I think, show that my estimates are not too sanguine, provided a connection of 4 000 lamps can be obtained in Darwen by the end of the first year's working. You will note that I have only allowed for an annual consumption of 13 units per lamp connected, this number being exceeded in each of the results given above. I refer to this more particularly, as some members of the committee appeared to think that I had over-estimated the probable number of units consumed per lamp. I have also made enquiries at Blackburn with regard to the falling off in the consumption of gas during the last 12 months, and find that this is directly traceable to the large number of mills and factories which have been closed owing to the bad trade in the town. I find also that so far as concerns that portion of the town which is within the area of the electricity supply there has been no appreciable falling off in the consumption of gas.—Yours faithfully,

E. M. LACEY.

LEGAL INTELLIGENCE.

A MOTORCAR TRANSACTION.

In the Queen's Bench Division on Monday, before Mr. Justice Wright, Koosen *v.* Rose was an action brought by Mr. John Adolphus Koosen, a gentleman residing at Southsea, against Mr. S. Rose, a bicycle manufacturer, carrying on business at Southsea, to recover £150, the price of a motorcar. Defendant denied liability.

The plaintiff's case was that in August last he had at Southsea a motorcar, which had been previously exhibited at the Imperial Institute and Hurlingham. The defendant was anxious to purchase a machine of the kind, and plaintiff said that after having had a trial of the car the defendant agreed to purchase it for £150—£100 down, and £50 in three months. Plaintiff further said that the defendant did not pay the £100, and afterwards refused to take the car.

Defendant said the arrangement between him and the plaintiff was that if the car worked satisfactorily at the carnival held on Southsea Common on the afternoon of Saturday, August 22, he would purchase it. The car, instead of working properly, stopped and had to be pushed home. Under these circumstances defendant said he was not bound to take the car.

His **Lordship** gave judgment for the plaintiff.

CLAIM FOR TELEPHONE WIRE.

At the Huddersfield County Court on November 12, an action was concluded in which the National Telephone Company sought to recover £10 from Messrs. E. A. Beaumont and Co., accountants, Huddersfield, for telephone wire and instrument.

Mr. Tetley (Wade and Co., Bradford) was for the Company, and Mr. F. A. Reed (Learoyd and Co.) for the defendants.

The case was originally brought in November last year, and had been adjourned from time to time.

His **Honour** now decided against the defendants on various points that had been raised.

Mr. Reed asked for liberty to appeal, on the ground that as between the parties there was no mutuality, and that there was no certainty as to the rent.

His **Honour** granted the application.

COMPANIES' MEETINGS AND REPORTS.

WEST INDIA AND PANAMA TELEGRAPH COMPANY, LIMITED.

The general meeting of this Company was held on Wednesday at Winchester House, E.C., Mr. C. W. Earle presiding.

In moving the adoption of the report the **Chairman** said the half-year under review was the better portion of the year, as it was the half-year in which the sugar crop in the West Indies was ready for shipment, and therefore it must always be expected that the second half of the year would not be so favourable in the way of traffic. For the half-year up to June last the Board were able to pay the largest dividend that had ever been paid. For the 25 years during which the Company had been in existence the dividend had never been so much as 1s. 6d. on the ordinary shares, and therefore what they were paying was so far satisfactory, although in comparison with what it ought to be it was very much the reverse. During the half-year there had been an increase in the receipts of £2,468 as compared with the corresponding period of the previous year, and there was an apparent increase of £332 in the expenses. The small increase in the total expenses was really in one item—the reserve for depreciation of ships, and there had been other small decreases. The Board were of the opinion that the rate of writing off for depreciation on that account was not sufficient, and that the reserve was not sufficiently high considering the age of the ships, and they had therefore written off £1,000 from that account. There was no doubt that the traffic of the half-year had been increased by exceptional circumstances. The political excitement in British Guiana had no doubt been the cause of some extra Government traffic, and to that they must therefore attribute some of the increased receipts. At the last meeting he called the attention of the shareholders to the Bermuda-Jamaica extension, which, it appeared, the Government were still very anxious to promote. The subject was brought before them particularly on that occasion, owing to a reply of Mr. Chamberlain in the House of Commons, in the course of which he stated that the Government were negotiating and were anxious to make that connection. It seemed that they were still anxious about it, but the difficulty was to serve the small traffic of the West Indies. Many of the Company's stations at the present time hardly ever sent a message, but they were compelled to be there owing to the Act originally passed and the obligations imposed upon the Company. The fact was that almost the whole use of the West India and Panama Company was Government service. The duty of the Company was to knit together the colonies and protect them from disaster and from rebellion such as they had before the telegraph existed in Jamaica. The receipts for the last five years had averaged £57,000 per annum. In the original prospectus, with which he might say the present Board had nothing to do, it was estimated that the traffic receipts would be £156,000 a year, and the shareholders could therefore easily see what had been the cause of the present unfortunate position of the Company. The question of the Bermuda-Jamaica cable was one that was always giving a great deal of anxiety, as in those matters there was always a danger of other people coming in with a low contract to perform the work. The promoter of a company agreed with a cable manufacturer to carry out the work, and then they put in the prospectus that the cable was subsidised by her Majesty's Government, so that people thought the 4 per cent. held out was as good as consols. The Treasury took the lowest offer that was made, and there was no guarantee whatever for the permanence of the undertaking. He looked with a considerable amount of alarm upon what was a new policy in this country, the proposals of the Government to subsidise at the expense of the ratepayers competition with enterprises such as theirs, and it was very damaging to the future enterprise of the country that such a state of things should exist.

The report was adopted and the dividend approved.

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CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Seraing.—November 26 is the date for applications to the Provincial Authorities at Liège for a concession for making and working a tramway at Seraing.

West Looe.—The Parish Council invite tenders for the lighting of the place with gas, oil, or electricity. Full particulars from Mr. Wm. Hicks, hon. clerk, West Looe Parish Council. Tenders to be in by November 28.

Hanover.—Tenders will be received on November 28 for 5,170 telegraph posts for the Prussian Railways. Particulars for 50pf (6d.) from the office, Rechnungsbureau der Königl. Eisenbahn Direktion, Joachimstrasse 7, Hanover, Germany.

Karlsruhe.—Tenders will be received on January 2 next for an electric lighting installation for the railway station and pier at Constance for the Grand Ducal Railway Authorities. Particulars are obtainable for 10 marks (10s.) from the Generaldirektion, (Centralbureau) Grossh. Badischen, Staatseisenbahnen, Karlsruhe. Germany.

South Shields.—The Corporation require tenders for a steam alternator and a rectifier, and extension to switchboards. Tenders are to be delivered by November 23. Specifications, etc., can be obtained at the Borough Electrical Engineer's Office, West Holborn, South Shields, on and after November 9, on payment of £1. 1s. (returnable).

Hartlepool.—The British Electric Traction Company, Limited, of 1 and 2, Great Winchester-street, London, E.C., on behalf of the Hartlepool Electric Tramways Company, Limited, invite tenders for the construction of the permanent ways. Particulars, specifications, plans, and form of tender may be obtained from Mr. J. Vincent Kitchener, secretary, London, on deposit of £5, which will be returned on receipt of a bona fide tender.

Warrington.—The Cheshire Lines Committee are prepared to receive tenders for the supply during the year 1897 of telegraph materials, instruments, wire, etc. Patterns can be seen and specifications with forms of tender obtained upon application to Mr. S. Saxon Barton, storekeeper, Cheshire Lines, Warrington. Tenders, sealed and endorsed, to be sent to Mr. Glegge Thomas, secretary, addressed Cheshire Lines Stores Department, Warrington, not later than 10 a.m. on November 28.

Dublin.—Tenders are required for the supply of general stores and sundries during year ending December 31, 1897, for the Dublin United Tramways Company. Forms of tender (price 1s. each), conditions, and all information can be obtained and patterns seen at the Company's Offices, 9, Upper Sackville-street, Dublin, until the 30th inst. Tenders, sealed and marked outside "Tender for Stores," and addressed to the Chairman, to be lodged with Mr. Wm. Anderson, secretary, by 30th inst.

Bury.—The Corporation are prepared to receive tenders for the wiring of the municipal offices, Bank-street and Parson's lane, Bury. Copy of specification and form of tender may be obtained on application at the office of the Borough Engineer, and on payment of a deposit of 10s. 6d., which will be returned on receipt of a bona fide tender. Sealed tenders, endorsed respectively "Wiring—Bank-street," "Wiring—Parson's-lane," to be delivered at the office of Mr. John Haslam, town clerk, on or before noon on November 30.

Hanley.—The Corporation require tenders for air-compressors (alternative arrangements driven by steam and by electric motors), and alternating-current electric motors at the sewerage works. Full particulars, specifications, bills of quantities, and forms of tender may be obtained at the office of Mr. Joseph Lobley, borough engineer and surveyor, Town Hall, Hanley. Contracts will only be given to firms paying the standard rate of wages. Sealed and endorsed tenders must be sent to the Borough Engineer before Monday night, 30th inst.

Deptford.—The Commissioners of Baths and Wash-houses for the parish of St. Paul, Deptford, invite tenders for proposed electrical installation at the public baths, now in course of erection. Specification, form of tender, and particulars may be obtained at the offices of the architect, Mr. Thomas Dinwiddy, Greenwich, and 5, Whitehall, S.W., on payment of £5 deposit, to be returned on receipt of a bona fide tender. Sealed tenders to be delivered to Mr. Arthur Huntley, clerk, Vestry Offices, 20, Tanner's-hill, Deptford, before 4 p.m. on 30th inst.

Greenhithe. — The Greenhithe and Knockholt Lighting Inspectors require tenders for lighting, cleaning, and extinguishing the lamps in the said district from December 1 next to November 30, 1897, both inclusive (except the months of June and July) from sunset to 1 a.m., for either one, two, or three years at the option of the inspectors. Tenders to state the price per lamp and the proposed method of lighting, and to be addressed to the Lighting Inspectors, Railway Hotel, Greenhithe, and delivered there before 8 p.m. on 24th inst. Mr. A. H. Walter, clerk.

Copenhagen.—Provided the City Council will vote for spending the necessary amount, an electric station is to be built in Vesterbro, Copenhagen, and tenders are invited for the delivery of (1) boilers, (2) mechanical and electrical plant, and (3) network, in accordance with the description. Conditions and plans to be had upon application to the Electrical Station, 30, Gothersgade, Copenhagen. For each specification a fee of 50 kroner is charged, which is returned on acceptance of the tender. Tenders will be received at the office of the fourth division of the Magistracy until December 4 at 12 noon.

York.—The directors of the North-Eastern Railway require tenders for the undermentioned articles, in such quantities as they may require, during the six months ending June 30, 1897, delivered carriage paid at the company's telegraph stores at York: (1) telegraph apparatus; (2) telegraph wires and line stores. Payment for each month's delivery will be made at the end of three clear months, or in cash, less 2½ per cent. discount. Forms of tender may be obtained on application to Mr. Graves, Telegraph Department, York, and tenders must be sent in to the secretary, Mr. C. N. Wilkinson, at York, sealed and marked "Tender for Telegraph Stores," not later than noon on Monday, November 23.

Monmouth.—The Town Council require tenders for the following: (1) machinery (consisting of turbines, alternators, steam-engines, boilers, electric motors, sewage pumps, etc.); (3) cast-iron pumping main; (4) electric lighting mains. Plans may be seen on and after 19th inst. on application to Messrs. Bramwell and Harris, engineers, 5, Great George-street, Westminster, S.W., or to the Town Clerk, Monmouth, from either of whom may be obtained, on deposit of £2. 2s. (to be returned on receipt of a bona fide tender), a printed form of specification and tender for either contract. Tenders, on the prescribed form, must be delivered with the specification attached (enclosed in a sealed envelope), endorsed "Sewage-Disposal, Tender for No. —," and addressed to Mr. T. R. Oakley, town clerk, Monmouth, by 12 noon on November 23.

York.—The Corporation invite tenders—(Section A) supply and erection complete of plant in a central electric lighting station; (Section B) supply, laying, and connecting complete of a system of mains; (Section C) supply, erection, and connection of arc lamps; (Section D) running the whole system for a period of years. The whole work is to be in accordance with the specifications and drawings prepared by Prof. Alexr. B. W. Kennedy, M.I.C.E., the consulting electrical engineer to the Corporation of York. Firms willing to undertake the whole or any section of above work may obtain copies of the specifications and drawings on application to Mr. William Giles, acting town clerk Guildhall, York, and on making a deposit of £2. 2s., which will be returned on receipt of a bona fide tender. Sealed tenders, endorsed "Electric Lighting," to be delivered by 30th inst.

Maryborough (Ireland).—Tenders are invited for the supply and erection of an electric light installation at Maryborough District Lunatic Asylum by the Commissioners for the Control of Lunatic Asylums. Tenders should be sent in a sealed envelope, endorsed outside "Tender for Electric Lighting, Maryborough Asylum," and addressed to the Secretary, Board of Control, Customs House, Dublin, and should be accompanied by a separate sealed envelope similarly addressed and endorsed, containing the detailed estimate, by 10 a.m. on 23rd inst. Forms of tenders and copies of specification will be issued on application to the Office of the Board of Control of Lunatic Asylums, Customs House, Dublin, on deposit of £3. 3s., which will be returned to all persons who have sent in bona fide tenders. Plans can be seen at the office of the electrical engineer, Mr. Walter Leake, 35, Dame-street, Dublin.

Southampton.—The Corporation invite tenders for the supply and laying of (*a*) insulated electric mains, (*b*) conduits and drawing-in boxes. Specifications and forms of tender can be obtained on and after 20th inst. at the Municipal Offices, Southampton, or at the offices of the engineers, Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster, on payment of a fee of £3. 3s., which sum will be returned on receipt of a bona fide tender. The contractor will be required to pay not less than the minimum standard rate of wages for the time being in each branch of the trade. The contractor whose tender is accepted shall enter into a formal agreement, under seal, with sufficient sureties for the fulfilment of contract. Sealed tenders, endorsed "Electricity Supply, Tender for Contract No. 2," must be sent to Mr. George B. Nalder, town clerk, Municipal Offices, Southampton, at or before 12 noon on December 4.

Ayr.—The Electric Lighting Committee require tenders for the supply and erection of the following plant (the whole bound up in one specification, price £2. 2s., returnable on receipt of a bona fide tender): (Section A) boiler-house plant—two Lancashire boilers and fittings, mechanical stokers, extensions to economiser, feed-pump, steam and exhaust pipes, valves, etc.; (B) engine-house plant—two 200-kilowatt steam alternators and condenser; (C) underground work—cables and culverts. Tenderers are at liberty to tender for either section, but not for part of a section. The ground plans of plant and specification, with terms and conditions of tenders and contract, may be obtained at the offices of Mr. Robert Hammond, the consulting engineer to the Corporation, Ormond House, Great Trinity-lane, London, E.C., on payment of £2. 2s. for each copy, which sum will be refunded on the return of the specification filled up with a bona fide tender. Tenders, sealed and marked "Tender for Electric Lighting," must be addressed to Mr. A. G. Young, town clerk, Council-chambers, Ayr, N.B., and be delivered by November 25.

Southampton.—The Corporation require tenders for the erection of buildings for an electric generating station, including engine-house, boiler-house, pump-room, and offices, chimney shaft and flues with accessories thereto, to be situated on the ground belonging to the Corporation, comprising and adjoining the present electric light station between Back-of-the-Walls and Canal-walk. Specifications, quantities, and form of tender can be obtained and the drawings can be seen at the Municipal Offices, Southampton, or at the offices of the engineers, Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster, on payment of a fee of £3. 3s., which sum will be returned on receipt of

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a bona fide tender. The contractor will be required to pay not less than the minimum standard rate of wages for the time being in each branch of the trade. The contractor whose tender is accepted shall enter into a formal agreement, under seal, with sufficient sureties for the fulfilment of contract. Sealed tenders, endorsed "Electricity Supply, Tender for Contract No. 1," must be sent to Mr. George B. Nalder, town clerk, Municipal Offices, Southampton, at or before 12 noon on December 4.

West Ham.—The Town Council require tenders for the supply of the following: four steam alternators and exciters; surface condenser and pumps; station switchboard, etc.; high and low tension mains, etc.; transformers, sub-stations, etc.; instruments; arc lamps, posts, etc.; crane. Plans of the suggested arrangements, specification, form of tender, and further particulars may be obtained at the office of Mr. John J. Steinitz, borough electrical engineer, Town Hall, Stratford, E., on the deposit of a £5 Bank of England note, which will be returned on receipt of a bona fide tender. Tenders, endorsed "Tender for Machinery, etc.," to be sent to Mr. Fred. E. Hilleary, town clerk, Town Hall, West Ham, by 4 p.m. on November 24. The contractor will be required to enter into a bond, with two sureties, for the performance of contract, and no work will be ordered under the contract until such bond has been duly executed. The contractor whose tender is accepted, and with whom a contract is entered into, will be required to pay the whole of his workmen such rate of wages and observe such hours of labour as are recognised by the workmen's trades unions and in force at the time of signing the contract. In the event of any breach of such agreement the Council will enforce the penalty clause in its entirety.

RESULTS OF TENDERS.

St. Pancras.—The Vestry have accepted the tender of Mr. T. E. Kershaw for supplying and erecting the additional arc-lamp pillars at £8. 5s. each.

Blackpool.—The Electric Lighting and Tramways Committee have accepted the tender of Messrs. Askam Bros. and Wilson for the centre channel for the Station-road tramway.

BUSINESS NOTES.

Devizes.—It is proposed to instal the electric light in the Wilts County Lunatic Asylum.

Mexico.—There is a scheme on foot to furnish electric power to the city from peat beds nine miles distant.

British Electric Traction Company, Limited.—Letters of allotment in this Company have been posted.

Wilmslow.—The Local Authority intend to apply to the Board of Trade for an electric lighting provisional order.

Personal.—Mr. Henry F. Lewis has retired from the position as manager to the London Electric Omnibus, Limited.

Rangoon.—The Municipality have recommended an expenditure of about £250 for an experimental lighting station.

Burton.—The Town Council are applying to the Local Government Board for power to light the library with electricity.

The Jandus Arc Lamp.—Messrs. Drake and Gorham inform us that the demand for this lamp is growing tremendously.

Leeds.—The City Council have decided to promote a Bill in Parliament to construct and work new tramways in the city.

Paisley.—The Corporation have agreed to acquire the site offered by Messrs. Kirkwood, Baird, and Co. as an electric station.

Buenos Ayres.—The report of the Board of the Central Produce Market states that the electric light has been provided in No. 8 block.

Battersea.—The Vestry have decided to borrow £5,000 for the electric lighting of the town hall, municipal buildings, and public library.

Farnworth.—At the District Council meeting the question of electric traction and electric lighting was referred to a sub-committee.

Simla.—We learn that the tenders for the electric lighting scheme have been received, and probably by this time the selection has been made.

Hull.—Mr. Skinner has been appointed chairman of the Corporation Electric Lighting Committee and Mr. Millington as deputy chairman.

Birmingham.—The City Council have decided to spend £10,143 in providing an electric light installation at the new meat market and slaughter-house.

Withington.—The Urban District Council have given notice that they are applying to the Board of Trade for a provisional order to supply electricity.

Luton.—Councillors Green, Cumberland, Ellery, Wilkinson, Smith, Harman, Cain, and Warren have been appointed the Electric Lighting Committee.

Ventnor.—The Local Authority intend to apply to the Board of Trade for a provisional order to supply electricity under the Electric Lighting Acts in their district.

West India and Panama Telegraph Company.—For the two weeks ended November 15 the receipts were £2,337, as against £2,134 for the corresponding period of 1895.

Aston Manor.—At the monthly meeting of the District Council sanction was received from the Local Government Board for a loan of £350 for electric lighting (additional plant).

Ealing.—The surveyor reported at the District Council meeting that the number of private lamps connected with the mains was now 9,160, and there were 150 more applied for.

Eastern and South African Telegraph Company.—Numbers are published of 5 per cent. first mortgage debentures of this Company, drawn for payment at par on January 1 next.

Cork.—The Lord Chancellor of Ireland has approved the tramway scheme of the Cork Electric Tramway Company, Limited. The lines will be seven or eight miles long.

Manchester.—The City Council have approved the promotion in the next session of Parliament of a Bill seeking authority to work the tramway system by the use of electric or other power.

Lancaster.—The Electricity Committee has been appointed as follows: Aldermen Kitchen, Smith and Bell; Councillors Preston, Hall, Storey, Leeming, Atkinson, Heald, Warriner, Huntington, and Little.

Indian Import Duties.—It is notified in the *Gazette of India* that machinery for the generation of electricity for purposes of lighting—namely, dynamos and connections—are exempted from import duty.

Cromer.—The Urban District Council have resolved not to proceed any further with regard to the provisional order on account of the cost of obtaining it being so great. The Clerk said it would cost £300.

Eccles.—The Town Hall and Electric Lighting Committee has been constituted as follows: Messrs. Alderman Kendall and Wilkinson; Messrs. Councillors Broughton, Corner, Mort, Oldfield, Pearson, and Plews.

Kensington.—At the Vestry meeting several questions were asked as to whether the Vestry could not utilise the house refuse to produce electricity for the supply of motor power for the dust, slop, and water vans.

Derby.—It was stated at the Town Council meeting that the Council were supplying lamps to those that wished to have them, but they were not supplying lamp fittings to the detriment of the tradesmen in the town.

Worcester.—At a special meeting of the City Council it was decided, owing to the development of the electric light in the city, to put in another cable from the generating station to the city, at a cost of £1,338.

Yeovil Motor Car and Cycle Company, Limited.—This Company has been registered, with a capital of £1,000 in £1 shares, to carry on the business of carriage and van builders, motorcar, and cycle manufacturers, etc.

Liverpool.—The City Council have decided to promote a Bill in Parliament to enable the Corporation to purchase the tramways, which are now in the hands of a company. The motive power has not yet been decided upon.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended November 15 amounted to £1,143, as compared with £1,028 in the corresponding week of the previous year, being an increase of £115.

Camberwell.—The Baths Committee reported at the Vestry meeting that above 45 cells of the electric accumulators required renewing at an estimated cost of 48s. each cell, and they recommended that tenders be advertised for.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ended November 13 were £1,875. 6s. 3d., compared with £1 938 16s. 7d. for the corresponding period of last year, being a decrease of £63. 10s. 4d.

Aberdeen.—The Gas and Electric Lighting Committee has been appointed as follows: Councillor Johnston (convener), Lord Provost Mearns, Bailie Young, Councillors Boddie, Croll, Fleming, Gray, Maitland, Bain, Sangster, and Skinner.

Eastbourne.—The Lighting and General Purposes Committee has been appointed for the year as follows: the Mayor, Aldermen Burt, Pocock, and Sutton, and Councillors Bradford, Breach, Job, Newman, Pearce, Rowe, Simmons, and Wright.

Beccles.—At the Town Council meeting Councillor King moved for a special committee to report on the present system of public lighting and the desirability of adopting the electric light. Councillor Buck seconded, and the resolution was carried.

Westralian Electric Lighting and Supply Company.—The Municipal Council of Coolgardie have decided that the number of arc lamps in the town shall be increased from eight to twenty, and a further contract with this company has been accepted.

Maidenhead.—The Lighting Committee of the Town Council have been reappointed, with the addition of Messrs. Tilly and Pearce, and they are meeting this week so that expression may be given to the wishes of the town in regard to public lighting.

Continental Water and Electrical Power Syndicate, Limited. This Company has been registered, with a capital of £26,000 in £1 shares, primarily to adopt and carry into effect two several agreements, the further objects being sufficiently indicated by the title.

British Electric Traction Company.—Letters of allotment in this Company have been posted. We understand the public did not respond very freely, but the Electric and General Investment Company and their financial friends have provided the necessary capital.

Argentine.—The Government of Mendoza has granted a concession for providing that city with electric light and power, making use of the fall of the river. Electric cars are also to be run in the city. The concession is for 99 years, after which period the whole of the plant will become the property of the Local Government.

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Maryport.—The electric light has gained a footing in this town, and the premises of Mr. H. Nixon, watchmaker and jeweller, of Crosby-street, have just been provided with an installation driven by a "Demon" gas-engine, on the Otto principle, of 1¾ b.h.p.

Cumberland.—Messrs. George Wilson and Co., Anchor Electric Works, Aberdare, have just completed a dynamo capable of supplying 300 c.p. for the electric lighting of the works of the Whitehaven Hematite Iron and Steel Company, Cleator Moor, Cumberland.

Llanelly.—At a meeting of the Chamber of Commerce many complaints were made as to the state of the gas lighting, and Mr. Wm. Bowen said it was his intention to move a resolution calling upon the Council to do all they could to introduce electric lighting into the town.

Ulverston.—The Rural District Council have resolved that the consent of the Council to the application of the Windermere and District Electric Lighting Company for an extension of time within which to make the necessary deposit under the order should not be granted.

New Carbide Syndicate, Limited.—This Company has been registered, with a capital of £2,400 in £10 shares, to acquire, develop, and turn to account a patent for the manufacture of carbide of calcium or other chemicals used in the manufacture of acetylene gas, etc.

O. Berend and Co., Limited.—This Company has been registered, with a capital of £20,000 in £1 shares, to enter into an agreement with O. Berend and Co., and to carry on in all or any of their respective branches the businesses of electrical, mechanical, and general engineers, etc.

Bexhill.—The Urban Council have decided to apply for a provisional order to supply the electric light, but have agreed to withdraw from proceeding with their application if power was given them to purchase within 14 years the undertaking which a company has decided to establish.

City and South London Railway.—The returns for the week ended November 15 were £1,078, compared with £958 for the corresponding period of last year, being an increase of £120. The total receipts for the half-year 1896 were £18,825, compared with £17,616 last year, being an increase of £1,209.

Shaftesbury.—The Belle Vue Ironworks have recently been fitted with the necessary appliances for lighting by electricity. The electric wires and lamps and the necessary machinery have been laid throughout the several workshops and sheds by Mr. Charles Farris, a son of the proprietor.

Exeter.—When the City Council were considering the electric lighting question they addressed a number of queries to 55 other municipalities where electric light was in use or being installed. The replies have been printed and bound and form a most useful book of reference with regard to that particular subject.

Watford.—Mr. H. H. Richardson, solicitor to the Ratepayers' Association, points out in reference to "Dogberry's" paragraph in the *City Press* that the introduction of the electric light into Watford is due to the foresight and energy of Mr. A E Pridmore, C.C., who is a leading member of the Watford Town Council.

Birkenhead.—The Town Council have appointed the Gas, Water, and Electrical Committee as follows: Aldermen Bloor, Getley, Lees, Rawcliffe; Councillors Bennett, Fiddes, Goodwin, Hazlehurst, Illingworth, B. Jones, J. M. Kelly, Lilwall, M'Gaul, Oates, W. Pearson, and the chairman of the Finance Committee.

Batley.—The Mayor (Alderman B. P. Nettleton), in thanking the Town Council for his re-election, said that as the electric light had been introduced into as many as 13 mills, some arrangements should be made whereby those only who assisted in the making of the profits by the consumption of gas should have the benefits of the profits.

Personal.—We understand that Mr. W. Worby Beaumont, M.I.C.E., who has for some years been identified with the joint editorship of the *Engineer*, resigned his editorial position some time ago in order that he might hereafter devote himself entirely to his consulting engineering practice at his offices in the Outer Temple, 222, Strand.

Nice.—According to the wish expressed by Mr. Dosse, Queen Victoria's director of Continental journeys, the Municipality have authorised the electric tramway company to remove the rails from the Avenue Victoria and to replace them on the eastern road, thus diverting the traffic from the vicinity of the western wing of the Hotel Cimiez.

Whitehaven.—At the Town Council meeting the Water and Lighting Committee reported that Messrs. Siemens had begun again to lay the new cables, starting at Solway View and working downwards and crosswise. Councillor Musgrave moved the confirmation of the minutes, which was seconded by Councillor Barr, and agreed to.

Edison and Swan United Electric Light Company, Limited. An extraordinary general meeting of the Company will be held at the Cannon-street Hotel, E.C., on Tuesday, November 24, 1896, at 12 noon, to consider the question of amalgamating with the Manchester Edison-Swan Company, Limited, and also the raising of new debenture stock.

Carlisle.—Application is to be made in the ensuing session of Parliament for powers enabling tramways to be laid in the city. The initiative is being taken by a Birmingham syndicate, and it is understood that the service will embrace Stanwix, Botcherby, and other suburbs, and the principal streets leading from the centre of the city to them.

Leatherhead Electric Lighting and Power Company, Limited. This Company has been registered, with a capital of £1,000 in £5 shares, to carry on the business of suppliers of electric light, heat, and power, as electricians, electrical and mechanical engineers, fitters, machinists, etc.

Armstrong-Dove Motor Syndicate, Limited.—This syndicate has been registered, with a capital of £6,000 in £10 shares, to enter into an agreement with T. Armstrong and L. Dove, and to carry on the business of motor manufacturers, electricians, cycle manufacturers, carriage builders, engineers, machinists, fitters, founders, wire-drawers, tube makers, etc.

Roller Bearings.—The Roller Bearings Company are executing orders for the Liverpool Overhead Company and various tramway and motorcar companies. Arrangements have also been made for fitting the express carriages in connection with the circular railway which it is proposed to construct and equip in connection with the Brussels Exhibition of 1897.

Hammersmith.—Mr. Searle stated at the Vestry meeting that in two years' time he hoped the arrangements for the introduction of electric lighting into the parish would be completed. He was convinced that the scheme would pay its expenses, and the cost of the light would not be prohibitory. In fact, the charges would compare favourably with the price of gas.

Copper Statistics.—Statistics furnished by Messrs. Henry R. Merton and Co. show that the total stocks on November 15 were 35,597 tons, against 35,441 tons on October 31 last, 34,077 tons on October 15, and 50,383 tons on October 31, 1895. The totals include the quantities advised by mail and cable, being respectively 4,250 tons, 4,100 tons, 3,650 tons, and 3,400 tons.

Change of Address.—Mr. J. A. Blackwood, secretary to the Fowler-Waring Cables Company, Limited, informs us their registered address for the future will be 110, Fenchurch-street, E.C. This change of premises has become necessary to meet the demands of a largely increased business in electrical cables and the addition of the new indiarubber department.

Rottingdean Electric Lighting and Power Company, Limited. — This Company has been registered, with a capital of £1,000 in £5 shares, to generate, produce, store, accumulate, and distribute electricity, electromotive force, or other similar agency, and to carry on the business of electricians, mechanical engineers, and electrical apparatus manufacturers.

Walton-on-Thames Electric Lighting and Power Company, Limited.—This Company has been registered, with a capital of £1,000 in £5 shares, to carry on the business of suppliers of electricity, as electricians, mechanical engineers, electrical apparatus manufacturers, etc., and to use or manufacture and put up telephones, telegraphs, electric bells, phonographs, etc.

Wigan.—The Gas and Electric Lighting Committee of the Town Council has been appointed as follows: chairman, Alderman Holmes; vice-chairman, Alderman Gee; the Mayor, the ex-Mayor, Messrs. Ackerley, Alker, Ashton, Booth, Gaskell, Farrimond, Clarke, Hilton, J. Johnson, McQuaid, Millington, Segrave, Richards, Riddlesworth, Riley, Walker, and Woods.

Traffic Syndicate, Limited.—This Company has been registered, with a capital of £10,000 in £1 shares, to promote the interests of the industry connected with the placing of cabs and all kinds of electrically or mechanically propelled vehicles on the common roads, and to carry on the business of electricians, mechanical engineers, machinists, fitters, founders, millwrights, etc.

Fire at Asbestos Works.—A serious fire occurred on Tuesday morning in a branch of the United Asbestos Company's premises at 302, West Ferry-road, Millwall, E. One building, used as a manufactory, and in which large quantities of raw materials were stored, was completely destroyed. The company wish to make it known that the fire will not stop business or the execution of orders.

Chester.—At the County Council meeting a notice from the Altrincham Electric Supply, Limited, under Section 12 (*a*) of the Ashton upon-Mersey Electric Lighting Order of 1896 of the intention of the company, after the expiration of one month from the date of the notice, to lay electric light mains in the area covered by the order was disapproved on the ground of incompletion of the plans.

Bromley.—A letter was read at the Urban District Council meeting from Mr. H. Podger, in reference to the proposal of the Council to transfer their electric lighting provisional order to a private syndicate, asking that the opinion of the ratepayers should be first obtained, as was done at Croydon, as to whether the District Council should carry out the scheme or transfer it to a syndicate.

Keswick.—Mr. J. H. Brodie writes to the *West Cumberland Times* pointing out that his letter to the Urban District Council was to enquire if the Council were prepared to treat for the sale, lease, or other disposition of the provisional order recently obtained for the supply of electricity, and not, as stated in the local paper, enquiring if the Council were prepared to treat for the purchase of the gasworks.

Middlesbrough.—At a special meeting of the Streets Committee of the Corporation the application of the Imperial Tramways Company to adopt the electric tram system and to extend their lines in different parts of the town was fully considered, and the following resolution was adopted: "That no further extension of the tramways by a private company be allowed within the borough of Middlesbrough."

Tunbridge Wells.—Several councillors seemed to be in a great hurry at the last meeting of the Town Council to have the electric light still more widely used for street-lighting, but the

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Lighting Committee pointed out that at present the system of putting electric lamps in the gas lamps was only on trial, though they believed it would turn out a great success. The Lighting Committee was reappointed.

Bangor.—The Electric Lighting Committee reported at the Town Council meeting that the solicitors to the Penrhyn estate offered, providing the town clerk would given an undertaking, that 5 per cent. interest should be paid on the amount of the purchase-money, the completion of the purchase to remain in abeyance for the present. The town clerk had given such an undertaking. The report was adopted.

Blackpool.—The Electric Lighting and Tramway Committee reported at the Town Council meeting that Mr. Nisbett, of the Electric Free Wiring Syndicate, had attended in reference to a scheme of house-wiring for electric lighting. The Electric Lighting and Tramways Committee was appointed as follows: the Mayor, Aldermen Cardwell and Bickerstaffe; Councillors Brodie, Grime, Bickerstaffe, Heap, Smith, and Wainwright.

Dublin.—The directors of the Dublin and Wicklow Railway propose to convert their line into an electric one and to run branches and offshoots through different parts of the counties of Wicklow, Wexford, and Carlow. The tramways company which previously bought up the Southern electric line are about to promote a Bill to enable them to run electric trams from the Rathmines, Rathgar, and Pembroke townships to the sea.

Leicester.—The Town Council have appointed the Gas and Electric Lighting Committee as follows: Mr. Bennion, Mr. Billings, Mr. Bruce, Mr. J. T. Clarke, Alderman Coleman, Mr. Edmands, Mr. Edwards, Mr. Faire, Mr. Flin, Alderman Lennard, Mr. Orton, Mr. Payne, Mr. Pochin, Mr. Rowlett, Mr. Smith, Mr. Spurway, Alderman Wood, Mr. H. H. Woolley, Mr. Joseph H. Woolley, Mr. Orson Wright, and Mr. T. Watson Wright.

Kingswood.—The question of engaging an expert to advise the District Council *re* the proposed purchase of the electric light apparatus, etc , again came up for discussion at the last meeting. The recommendation from the Lighting Committee was that an expert should be employed. The chairman said what they required was an expert to look at the plant and give his opinion to the Council on the whole thing. The recommendation was adopted.

Ashton.—The following gentlemen compose the Electric Lighting Committee: the Mayor, Aldermen Heginbottom, Hilton, Siddall, and Wilson, Councillors Andrew. Catlow Cooke, Hall, Hallam, Kelsall (deputy chairman), A. E. Mellor (chairman), Newton, Phillips, and Shaw. The draft agreement between the Corporation and the British Electric (Pioneer) Company relative to the supply of power to the tramway company is to be settled by counsel.

Flamborough.—At a meeting of the Parish Council Mr. E. Dunn (chairman) proposed: "That this Council approve of a proposed electric railway from Bridlington to Flamborough and believe if such a scheme be carried out will meet a great want and confer lasting benefits on the inhabitants of the village, and be a great accommodation to the general public who might wish to visit the place." Mr. Rawnsley seconded. The resolution was carried unanimously.

London Lighting Extensions.—The committee of the London County Council have passed notices of extensions from the Charing Cross and Strand Company (Blackmore-street and Endell-street, etc), from the House-to-House Company (Neville-street, Hollywood-road, and Wrights lane), from the Notting Hill Company (Bedford-gardens), from St. Pancras Vestry (Fitzroy street), and from the Hampstead Vestry (several streets, including Fitzjohn's-avenue and Adelaide-road).

Harrogate.—At the Town Council meeting the Lighting Committee was appointed as follows: the Mayor, Alderman Fortune, Hammond, Hudson, and Ward; Councillors Chippendale, Milling, Morrison, Myrtle, Scholes, Simpson, and Thwaites. The electrical engineer read a report as to the cost of an electric motor for crushing oats and cutting chaff at the town's yard, and it was resolved that an electrical motor and an oat-crusher and chaff-cutter be purchased at an estimated cost of £155.

Electrical Sanitation for Bombay.—The Municipality have had under consideration for some months the adoption of the Hermite process in that town. The report of their engineer, Mr. Hewett, who was recently in England and inspected the working of the Netley Hospital plant, was so favourable that they have now voted the funds for a considerable installation, and Messrs. Paterson and Cooper have received instructions to prepare the necessary machinery for shipment early in December.

Coseley.—At a special meeting of the District Council an engineer of the British Electrical Traction Company attended, and stated that the company were entering into negotiations for revolutionising the tramways in South Staffordshire by obtaining power to adopt overhead electric traction in lieu of steam. It was proposed to spend a million of money in reconstructing and extending the tramway, and it is believed the undertaking will prove remunerative, as by means of electricity a 10 minutes' service can be guaranteed.

Coventry.—The electric tramways company's annual supper was held last week. Mr. Councillor West presided, and an attendance of nearly 70 included Messrs. T. R. Whitehead (manager), G. F. Cowan (secretary), A. Hughes, R. Growse G. E. Watmough, H. J. Wimshurst, W. H. Cantrill, W. Browne, Inspector Green, etc. The toast list, which was a short one, included the loyal toasts, "The City Authorities," and "Success to the Coventry Electric Tramways, Limited." An enjoyable musical programme was arranged.

Glasgow.—The system of electric clocks which has been under the consideration of the Corporation for some considerable time was inaugurated this week. The system was originated and perfected by Prof. Becker, of Glasgow Observatory, from which the clocks will be regulated. There will be three circuits, one being placed in the Municipal Buildings in George-square. In due time the area will be extended, and the intention of the Corporation is to erect some 200 or 300 dials at the corners of the leading streets. The outlying districts will also be included.

Appointments Vacant.—The Electric Lighting Committee of the Hull Corporation are prepared to take one improver into their electric light works for a period of two years, at a premium of £30. All information can be obtained on application to the borough electrical engineer, electric light station, Dagger-lane, Hull —The Corporation of Bristol have a vacancy for an improver in their electric light station. Premium, £100. Applicants must have had experience in mechanical engineering. Particulars from Mr. Faraday Proctor, city electrical engineer.

Walsall.—The total number of consumers supplied on October 31 was 71. The total units generated at the station during the month of October was 13,069. The total output from the main generators was 12 287 units. The net income for the month was £174. 15s. 3d. The salary of Mr. Wyllie, the borough electrical engineer, has been increased from £150 to £200 per annum. The Electric Lighting Committee has been appointed as follows: Aldermen Baker, Brownhill, Evans, Lindop, Marshall, Newman, and Roper, Councillors Brownhill, Noake, Powell, W. Smith, and C. C. Walker.

Bristol.—The Bristol Tramways Company are about to make application to Parliament for the necessary powers to authorise the extension of their system as well as the adoption of electric traction on the whole of the present lines. The proposed extensions and adaptation of the old lines to electricity will involve an outlay of about £400,000, in connection with which a large proportion of the capital already spent, amounting to upwards of £300,000, will practically be wiped out of existence. The Corporation want to supply the electricity and the company want to supply their own.

Barrow.—Councillor Smith made a long statement at the County Borough Council meeting in support of his proposition that a separate committee should be appointed to deal with all the duties relating to the question of electric lighting. He argued strongly in favour of the introduction of the electric light, and reviewed the history of the movement from its commencement in the town. His speech was followed by a still longer discussion, but in the end his motion was lost by one vote, 11 voting for and 12 against. The Corporation are in possession of a provisional order which expires on July 5 next.

Llandudno.—At a meeting of the District Council the plans of Messrs. Dickenson, of Birmingham, for an electric tramway connecting Llandudno, Colwyn Bay, and Conway, came up for discussion Mr. Thomas moved the Council decline to consider the plans. He objected to Llandudno becoming like Blackpool and Douglas. Mr. Williams seconded. Mr. Hughes moved an amendment that the Council favourably consider the plans. He considered that tramways would benefit the whole district, and hoped to see the scheme carried out. Mr. Conway seconded. The resolution was carried by 11 votes to 3 for the amendment.

London Electrical Cab Company.—With a capital of £150,000, in £1 shares, the London Electrical Cab Company, Limited, has been formed to work and let out on hire in London electrically-propelled cabs. The prospectus states that the Company will work under a sole license from the British Motor Syndicate for the use of their patents in the metropolitan area, at a royalty of £4 per cab per annum, and will contract with the Great Horseless Carriage Company for their manufacture as required. The price to be paid for the license from the British Motor Syndicate is £50,000, in shares or cash, in addition to the royalty of £4 per cab per annum.

Ashton-upon-Mersey.—At the meeting of the Council a long discussion took place on the subject of the proposed tramways from Stretford along the Manchester-road to Peel Causeway. The chairman, Mr. H. V. Kilvert, moved: "That this Council is of opinion that any tramways on the high road would be distinctly injurious to the district, and is, therefore, opposed to either of the suggested schemes." Mr. A. Lawson seconded the resolution, which was adopted without discussion, and it was further agreed to send a copy of it to Dr. E. J. Sidebotham, the local representative on the Cheshire County Council, requesting him to urge the Council to actively oppose both schemes.

Monmouth.—At the meeting of the Town Council, the ex-Mayor reminded the Council that the contract with the gas company expired at the end of the year, and it would be necessary to consider how long it should be extended into the next year. The contract was an annual one. In view of this he had written to Messrs. Bramwell and Harris enquiring when there would be a probability of the electric light being in working order, and they had replied that with favourable progress it ought to be in operation by March next. Under those circumstances he would suggest that the gas contract be continued for six months, with the option of renewal for another six, and that the gas company be written to respecting terms. The suggestion was accepted.

Sheffield.—Gas has been superseded by electric light at the Cutlers' Hall. A committee of the Cutlers' Company was appointed some time ago to carry out the change, and they adopted the plans of Mr. S. V. Clirehugh, A.M.I.C.E , M.I.E.E., of Manchester, and placed the contract in the hands of Messrs. Verity, Limited,

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also of Manchester and of London. The whole of the lights in this part of the building will be controlled from a switchboard in the entrance to the Trade Marks Registry. Outside the hall, in Church-street, two large arc lamps are being fixed. Mr. Clirehugh has superintended the carrying out of his plans, and Mr. Charles S. Northcote, engineer and manager, has looked after the putting in of the installation on behalf of Messrs. Verity.

Cheltenham.—Colonel Marsh, R E., has held an enquiry into an application made by the Corporation for the sanction of the Local Government Board to the borrowing of £2,620 for the purposes of electric light extensions. It was explained that the money was required principally to meet demands for the electric light service beyond the districts contemplated in the estimates when the loan for £23,000 was obtained, though none of the proposed extensions would be outside the compulsory area. Alderman Norman said the output from the electric works now represented about £70 a week, and that the undertaking was expected to make a profit shortly. Mr. Kilgour (the electrical engineer to the Corporation) gave details of the extensions. There was no opposition to the application.

Bilbao.—A communication, dated October 28 last, has been received at the Foreign Office from Mr. G. S. Smith, her Majesty's Consul at Bilbao, reporting that a great extension of the use of electricity is going on in that province, but the British firms seem to take no part in it. Two electric tramways are likely in a short time to be made, and if any British firm desires to be given the contract they would do well to look into the matter without delay. The projected lines are (*a*) from Bilbao to Durango, about 18 miles long (the promoters are a private company); (*b*) from Zumuarraga to Zumaya, a distance of some 18 miles (permission for its construction is being sought by the Alcaldes of Azpeitia and Azcoitia, and it is proposed that the line shall be undertaken by a private company not yet formed).

Belfast.—Councillor Andrews, J.P., reported at the meeting of the Electric Committee that he had waited upon the Improvement Committee relative to the acquisition of the site at present occupied as a stoneyard for the proposed new station, and had arranged for a meeting the following day of representatives of all the committees interested in the yard accommodation with a view to the best arrangement being made for the requirements of all. Applications for supply of current for a large number of lamps were received and granted, and business not of public interest was disposed of. The Library Committee have agreed that Mr. M'Cowen, the electrical engineer, should draw up a specification in order that public tenders for the lighting of the library buildings by electricity might be invited.

Bournemouth.—The Bournemouth and District Electric Supply Company, Limited, have given notice of their intention to apply to the Board of Trade for a provisional order empowering them to produce, store, and supply electricity, electrical energy, and power within the municipal borough of Poole and the district of the Branksome Urban Sanitary Authority, and to break up various public and private thoroughfares as may be necessary for the carrying out of their work. It is proposed that electric lines shall within two years be laid down along the whole of the Poole and Bournemouth road and the High-street. The Town Council Lighting Committee has been appointed as follows: Alderman Cutler, Mr. Beckett, Mr. Gunning, Mr. Hawker, Dr. Kinsey-Morgan, Mr. Tuson, and Mr. Youngman.

Taunton.—Mr. H. W. Couzens, borough electrician, reported at the Town Council meeting that during the past quarter there had been considerable extensions and additions to the electric light undertaking, and they had connected up 10 new consumers and an aggregate of 200 lamps of 16 c.p. The Local Government Board enquiry for the additional loan had also been held, and after its conclusion the inspector visited the works and expressed his satisfaction with what he saw. They had fixed and lighted up the major portion of the lamps ordered in the Staplegrove road, effecting a marked economy in the first cost by utilising the old overhead wires for the purpose. The lighting up of the remainder was compulsorily delayed until the Great Western Railway Company gave their permission to cross their bridge at Fairwater.

Tunstall.—The clerk to the Urban District Council (Mr. A. P. Llewellyn) reported at the last meeting that he had lodged a memorial with the Board of Trade against the transfer of the Potteries Extension Tramways Order, 1896, from the promoters to the British Electric Traction (Pioneer) Company, but he had since ascertained that the company's financial position was considered satisfactory, he had received payment of the costs incurred by the Council when the order was promoted, and, from a letter the secretary of the company had written the Board of Trade, it appeared the company were quite willing to take over the obligations of the promoters under the agreement with the Council of July 1. It was decided that as soon as this agreement was transferred to the company the Council would be able to formally consent to the vesting of the order in the Pioneer Company.

Dundee.—At the Town Council Treasurer Ritchie moved that they promote a Bill in the next session of Parliament to enable the Gas Commissioners to borrow additional money, to extend the electric lighting area, and for other matters considered necessary. He remarked that they had until the month of March to prepare the Bill, and the notice which he proposed should be so wide that they could introduce anything they liked into the Bill. Ex-Provost Ballingall seconded, remarking that while there was a general demand for electric light they could do nothing in the way of meeting it until they got powers for extending the area. Messrs. D. J. M'Kinnon and James Perrin opposed the proposal, pointing out that the motion to proceed with the Bill had been rescinded at the concluding meeting of the last Council. After further discussion it was agreed by 18 votes to 9 to proceed with the promotion of the new Corporation Bill.

The New Electrical Carriage.—In the presence of a large number of people the first electrically-propelled carriage of the London Electric Cab Company was started from the Royal Hotel, Blackfriars, at 12.30 on Monday for the City. In the carriage were the Earl of Fingall, Mr. Frank Gardner, Mr. Davison Dalziel, and Mr. H. Mulliner, while Mr. Bersey, the inventor of this particular system, was on the box. The carriage, which attracted considerable attention, was driven down Queen Victoria-street, past the Mansion House, and round the Bank into Throgmorton-street, passing easily through the crowded traffic. In Throgmorton-street the members of the Stock Exchange turned out *en masse* to give the new vehicle a greeting. Those who were in the carriage spoke highly of the ease and facility with which it was guided through the crowded streets, and testified to the entire absence of any vibration.

Wolverhampton.—Notices have been posted in various parts of the Black Country and other places to the effect that application is intended to be made to Parliament in the ensuing session for an Act under the name or title of the Birmingham, Wolverhampton, and District Tramways, to authorise the construction of tramways in the parishes of Wolverhampton, Sedgley, Bushbury, Tettenhall, Upper Penn, Bilston, Darlaston, Wednesbury, Dudley, Kingswinford, Rowley Regis, Amblecote, West Bromwich, Handsworth, Harborne, and Smethwick, and that it is proposed to lay such tramways, or some part or parts thereof, along the road or street, or part of the road or street, in which those notices are posted. Plans of the proposed tramways will be deposited at the offices of the different public authorities on or before the 30th inst. The authorities concerned have already been approached on the subject, and further negotiations are proceeding.

Dudley.—At the Town Council meeting Alderman Bagott moved that application be made to the Board of Trade for a provisional order to enable the Council to supply the town with electricity for lighting and other purposes. Regarding the matter he mentioned the interview with Mr. Sellon, engineer for the tramway syndicate, who had told the Public Works Committee that if the Corporation supplied the electricity the syndicate would be a large consumer. The tramway amalgamation would be a most important matter for the town and particularly for Netherton. Mr. James Turner seconded. Councillor Taylor thought it would be better to purchase and municipalise the gasworks than to spend £24,000 on electric lighting. Alderman Bagott observed that towns which had their own gasworks, notably Walsall, were also adopting the electric light. If the Corporation did not supply the electric light the tramway syndicate would. The motion was carried.

Bradford.—The mayor (Mr. T. Speight) has been appointed chairman of the Gas and Electricity Committee, with Mr. W. E. Aykroyd as deputy-chairman. The funeral of Mr. Robt. Silk, who had been connected with the electricity works of the Corporation since their inception, took place this week at Undercliffe Cemetery. The deceased came from Siemens's works at Woolwich, and was known as a most skilful maker of "joints" Mr. Silk contracted a cold three weeks ago, and died on November 12. The coffin was covered with wreaths from the Electricity Committee, the officials at the town hall, and the staff of the electricity station. Among the mourners were Mr. A. H. Gibbings (electrical engineer), Mr. S. Dalton (assistant engineer), Mr. James Copperthwaite (chief clerk), Mr. F. Kershaw, Mr. J. Batten (street and drainage department), and Mr. W. Dryburgh. About 60 Corporation employés headed the funeral cortége.

Extension of Electric Lighting in the Metropolis.—The London Electric Supply Corporation have decided to apply to the Board of Trade for power to extend their area of supply to the south of Westminster Bridge, Parliament-square, and Victoria-street in Westminster; and to enable them to carry the scheme into effect, they propose to ask for powers to interfere with the tramway of the London Tramways Company in Vauxhall-road. The Fulham Vestry have given notice that they will next month apply to the Board of Trade for powers to supply their district. In laying their electric lines they propose to pass over, along, across, or under railways belonging to the Metropolitan, the Metropolitan District, the London and South Western, the Great Western, the London and the North Western, and the Midland Railway Companies. The Blackheath and Greenwich District Electric Light Company are proposing to extend their area of supply to the whole parish of Greenwich, as well as to the parishes of Charlton, Eltham, Kidbrook, Lee, and Lewisham.

Dover.—Councillor Edwin asked at the meeting of the Town Council when the report from the officers in respect to the tramways would be ready. The Town Clerk said they were only waiting to draw up the report, having got all the parts, and they hoped to present it shortly. Mr. Morley Fletcher's experimental vessel with apparatus for utilising the force of the sea waves as a source of power has been now some time in Dover Bay. Up to the present what has been worked is a small pumping plant. It is suggested, however, that in the case of generating an electric current, such as would be required to light a lightship or lighthouse, the motor would deliver on to the vessel a hydraulic supply under pressure, which, passing through a system of receivers and turbines, would drive the dynamo or generator. It is stated that the inventor's firm has already disposed of the British patent rights to a company entitled the Morley Fletcher Wave Power System, Limited, and the company have entered into a contract with Messrs. Maudslay, Sons, and Field, engineers, of London, for the construction of a very large motor plant of Mr.

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Morley Fletcher's design which is to be delivered on completion at Dover.

New Mutual Telephone Company, Limited. — This Company has been formed for the purpose of supplying within Manchester, Salford, and district an independent telephone service. The scheme was started by several gentlemen in Manchester. Before any fresh telephone service can be started it will be necessary to obtain a license from the Post Office, and according to a Treasury minute dated May 23, 1892, "no application will be entertained unless a formal resolution in its favour has been passed by the corporation or other municipal authority, and evidence given that there is sufficient capital subscribed to carry out the undertaking." The directors and members of the syndicate feel confident that these conditions will be fulfilled, and that the necessary license will be obtained; but if the license be not obtained, all the preliminary expenses will be borne by the syndicate, and all moneys paid by subscribers for shares in the present Company will (as soon as the necessary resolutions for winding up the Company voluntarily have been passed) be returned to them in full. The capital is £250,000 in shares of £5 each, of which 20,000 shares are now being issued.

Newington, S.E.—At the meeting of the Vestry Mr. Chandler asked if it was a fact that the Commissioners of the Public Baths and Wash-houses had given out the contract for the installation of the electric light to the baths and wash-houses, and, if so, to whom had such contract been given? Further, were clauses providing for the payment of the trade union rate of wages and observance of trade union hours inserted in such contract, and had the contractor power to sub-let his contract? In reply, the Clerk said that the contract for the engineering work had been let to Messrs. Clarke and Son, of 49, Moorgate-street, with the usual clauses as regarded wages, hours, and sub-letting. Mr. Chandler gave notice that he would move that the committee be requested to enquire as to whether the firm in question actually paid the trade union rates and observed the trade union hours. At the same meeting of the Vestry a long discussion took place upon the electric lighting question. The Electric Lighting Committee recommended the Vestry to issue the statutory notices of their intention to apply for a provisional order. An amendment that the question should not be put was lost, and the recommendation was agreed to.

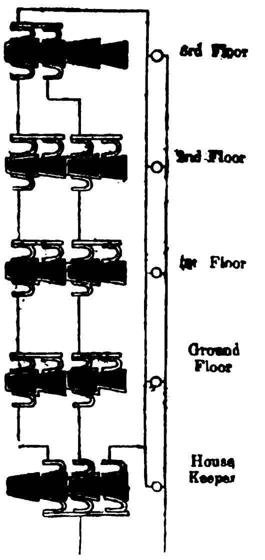
Islington.—A communication was received at the meeting of the Vestry from the Finance Committee of the London County Council with reference to the application of loans to the extent of £31,000 for electric lighting, which stated that the committee recommended the Council to sanction a loan of £24,000 on account. A letter was also read from the Council solicitor stating that interest on the loan would be charged at the rate of £2. 17s. 6d. per cent., and that the repayment would be spread over 42 years. Mr. Goodman said there would be no difficulty in getting the other £7,000. The delay and difficulty which had occurred arose from the fact that the Vestry had neglected to supply certain particulars. Mr. Stonelake asked, considering that the Shoreditch Vestry were contemplating the adoption of the electric lighting and laying mains along New North-road, whether the Electric Lighting Committee would consider the advisability of extending their system from Highbury-corner along Canonbury-road and New North-road to meet the Shoreditch boundary. Mr. Lambert said the committee would have to carry out the work they had in hand before undertaking new work. They were, however, in the hands of the Vestry.

Weston-super-Mare.—A meeting of the Urban District Council has been held for the purpose of considering and reporting upon an application having reference to the posting of notices in certain streets relative to the construction of a proposed tramway within the district. The Chairman explained that the meeting had been convened in compliance with a request from Mr. Brereton, C.E., for the purpose of giving instructions as to the posting of notices in relation to a proposed tramway along the streets within the district, as required by the Standing Orders of Parliament. Mr. Brereton explained that it was proposed to apply to Parliament for a Bill to authorise the construction of an electric tramway following the route stated. The Clerk stated that, failing any directions of the Council as to the posting of notices, the promoters would be authorised to post such notices along the route as they might consider best. The chairman (Mr. Harvey) proposed, and Mr. Gill seconded, a resolution recommending that the promoters of the proposed tramway be allowed to post the necessary notices in the streets along the proposed route, and the same was unanimously adopted. A special meeting of the Council was subsequently held, when the report and recommendations of the committee were adopted.

Colchester.—At the meeting of the Town Council the Electric Light Works Committee reported that they had inspected, in conjunction with Colonel Skinner, R.E., the corrugated iron building and the engine and dynamo for temporarily supplying electric light required for the new military hospital, and they expressed their satisfaction therewith. The Borough Surveyor reported that he and Mr. Kuner had inspected the north railway station, and that he considered 194 16-c.p. lamps would be needed and that the cost of laying the wires and providing lamps would not be less than £180. The town clerk was desired to send a copy of the report to the Great Eastern Railway Company, and state that the committee would be prepared to supply current at 6d. per unit provided the Eastern Counties' Asylum authorities agreed to take the light for the asylum building. The report was adopted. The Lighting Committee was appointed as follows: The Mayor, Aldermen Sanders and Wicks, Councillors Argent, Asten, Barritt, Bear, Clamp, J. F. Goodey, Littlebury, Moore, Peck, and Penney. The following were appointed on the Electric Light Works Special Committee: The Mayor, Aldermen Elwes and Wicks, Councillors Wilson, Marriage, Grimes, Peck, J. F. Goodey, Barritt, Argent, and Nash.

Morecambe.—Messrs. Lee, Harper, W. R. Brown, H. Baxter, and Miller have been appointed a sub-committee to look through the plans, specifications, and conditions relating to the electric light undertaking, to give such instructions as they consider advisable, and generally to supervise the carrying out of the work. Mr. Parker, electrical engineer, has met the Council with reference to the electric light scheme, and the subject was discussed in committee. In accordance with a resolution previously passed authorising the clerk to apply for a provisional order for the Council to purchase the electric light undertaking, it was resolved that Mr. Tilley, the clerk, on behalf of the Council, appoint Messrs. Hargreaves and Co. as parliamentary agents in the matter. Colonel John Ord Hasted, R.E., has held a Local Government Board enquiry with regard to applications made by the Council for sanction to borrow £59,200 for various works of improvement. These included £26,000 for the purchase of a portion of the undertaking of the Morecambe Electric Light and Power Company, and for works of electric lighting. The system proposed was described by Mr. Parker as having been adopted at Oxford, various parts of London, Liverpool, Brighton, Crystal Palace, Wolverhampton, and Walsall. The Morecambe district being a scattered one, in an almost continuous line, he was of opinion no other system would be found to answer. Mr. Jowett, secretary to the electric light company, stated that what the Council proposed to purchase for £3 897 had cost the company over £9,000. Mr. Loraine, barrister (instructed by Messrs. Toulmin, Ward, and Carruthers, solicitors, Liverpool), representing several property owners; Mr. Oglethorpe, representing Mr. Clark; and Mr. Sewart, representing the Rev. C. T. Royds; and Messrs. Fisher, landowners, although favourable to the scheme, strongly objected to the site selected for the electrical works as being utterly unsuitable, the means of access inadequate, and the works calculated to depreciate the value of adjacent property.

New Catalogue.—We have received direct from Berlin an English edition of the catalogue issued by the Allgemeine Elektricitäts-Gesellschaft. The main contents of it are similar to those of the catalogue of the Electrical Company, of Charing Cross-road. Information as to comparative weights of three-phase and direct-current motors is worthy of being abstracted. Thus a 40-b.h.p. motor of the three-phase type, running at 315 revolutions at 50 frequency, weighs about 3,000lb. A multipolar motor, direct current, of practically the same output at the same speed, weighs 5,150lb. This saving in weight in favour of the three-phase system is a great argument in favour of the type, especially when coupled with greater simplicity in working. The prices, as listed, show that the three-phase motors are cheaper than those worked by direct current. In the above case the saving is about 15 per cent. The adjoining diagram of switches and connections for staircase lighting, found further on in the catalogue, may be of interest to our readers. It will be noticed that with the "Royal" types of switches employed, the whole of the lights can be turned on or off on either landing at any time. The convenience of this arrangement on a long staircase repays for the extra cost of installing the same.



St Pancras.—At the meeting of the Vestry, which we briefly reported last week, Mr. E. Cox, chairman of the Electricity Committee, submitted an important report from the committee, which stated that they were unanimously agreed that the best means for preventing any of the thoroughfares lighted by arc lamps being left in total darkness through any interruption in the supply, will be to rearrange the whole of the present high-tension arc lamp circuits and connect every alternate lamp to the low-tension mains. The estimated expenditure for carrying out the foregoing improvements was £2,615. 15s., and this the Vestry agreed to. In consequence of the low-tension mains being laid in some thoroughfares on one side of the street only, and the demand for supply being greater than the present mains were capable of carrying, the committee recommended the laying of additional mains in various districts, at a further estimated expenditure of £3,966. The committee further stated that they thought it advisable that, beyond the thoroughfares to be lighted by arc lamps already sanctioned by the Vestry, the following districts should be added—viz., Haverstock-hill to the parish boundary, Fortess-road to the parish boundary, and along Highgate-road as far as Gordon House-road. The committee were given to understand that the Hampstead Vestry were proposing to light that part of Haverstock-hill situated in their parish, and negotiations were pending to mutually light the parts where the two parishes adjoin. The Islington Vestry were also contemplating lighting the Junction-road by arc lamps up to the Boston. In view of these extensions by the

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neighbouring parishes, it would be a distinct public advantage, apart from local considerations, that the lighting should be continuous, and thus avoid the necessary short breaks which would exist if the lighting was not extended to the points indicated. The cost of lighting these thoroughfares by arc lamps running half from the high and half from the low tension mains would be £2,100, and the committee recommended that sanction be given for carrying out the work. This was carried.

Incandescent Lamps at the "Empire."—Reference has already been made to the adoption of the "improved" electric incandescent lamp at the Empire Palace Theatre, and the lamp itself has been fully described in these columns. In addition, however, to the lighting of the auditorium and stage, there are some novel effects carried out in the ballet of "Monte Cristo" which are worth notice. By means of specially designed lamps of the company's type there is an illuminated waterfall in the second act, but the main display is in the cave scene. Here there are, firstly, a set of 108 pendant lanterns representing gems of different colours, each of which is composed of several lamps, over 600 being in operation. But the main novelty is in the production of electrical effects on the dresses and properties of 24 "coryphées" and 10 men dancers, each of whom carries an average of 100 miniature improved electric lamps specially shaped to suit the designs of the dresses. The interesting feature of this is that since it would be impossible to light such a number of lamps by means of current produced, as has been done heretofore, from accumulator cells carried by the dancers, special means were devised by Mr. Fanta by which the dancers' dresses are put in direct contact with the current from the mains of the Metropolitan Supply Company, but reduced to such a voltage that all danger of shock is avoided. This is done by a carpet or stage cloth, by means of which the current is conveyed to the shoes of the dancers or to wands carried by them, and the effect when a line of dancers breaks into sudden light is very striking. In the "Apotheosis" of the first act the combination of miniature lamps (over 7,000 in number) is made to represent a diamond throne, and jewellery in the form of crescents, tiaras, pearl festoons, lovers' bows, stars, crowns, etc.; the lamps in this case being constructed on the model of cut diamonds and round or oval pearls, and, finally, the whole number of 34 dancers with illuminated dresses are grouped in the back ground after having performed their dances unimpeded. The whole of the electrical effects are the work of Mr. Fanta, of the Improved Electric Glow Lamp Company, Limited, in conjunction with Mr. A. H. Walton, the Empire Company's consulting electrical engineer.

Swansea.—A special statutory meeting of the County Borough Council has been held to consider the adviseability of promoting a Bill in Parliament for the purchase of the tramways and the erection of electric lighting works, with a dust destructor in combination. Councillor Martin moved a resolution sanctioning the promotion of the Bill in Parliament. He said they would purchase the tramway system, and absolutely pay nothing for it. The consideration they offered was in the advancement of money to pay off mortgage debt, and to adapt the plant to electricity. The company undertook to return that money in 30 years and to pay interest plus ½ per cent. on the amount, and at the end of that period to give up the system to the Corporation. He did not see how they could get better terms. It might be asked what advantage the terms of the Corporation might be to the company. There was a substantial advantage, and he gave statistics to prove the increased value of tramway companies' shares after the introduction of electricity as a motive power. While ratepayers of Swansea got such a grand bargain, and from eight to nine years in advance of the statutory period enabling them to consider doing it, there was the additional advantage that while they could now light the town by electricity at a substantial profit, they could as a Corporation, with the tramways as a customer for surplus electrical power, be certain of an enormous profit. It had been said that electric lighting at Cardiff, Newport, and Bristol was a failure, but it was not the opinion of Bristol, Newport, and Cardiff people that their electric schemes were failures. He wished Swansea not to take notice of letters written by people interested in the gas company, and when the people saw such strenuous efforts made against electricity by the gas company they should see that the company feared that it would suffer to the advantage of the public. It had been urged by the opponents of the scheme that the cost of electricity must be 2d. per unit, but he showed that that was the cost as supplied to the customers, but Mr. Preece and Mr. Swinburne—two of the greatest authorities—said it could be generated at a farthing. It was proposed by the tramway company to take a million units, and with the present electric scheme the Corporation could supply it without adding a penny in wages, increasing the plant, and yet give the 12,800 lamps the plant provided for. The revenue from the tramway company for the electricity it would require would clear all the cost of the Swansea electrical station, and all that the Corporation would have to do would be to pay interest on capital and sinking fund. Instead of selling electricity to private consumers at 6d., as had been proposed, they would be able to sell it at 3d., and most likely 2d., with a considerable profit. Mr. Lindley seconded. He gave his personal experience of the success of the electric tramcars at Bristol, and said the fact that Swansea was enabled to add to its electric lighting the sale of a day load to the tramway company which ensured such great profits had made the town the envy of other towns not similarly situated. A vote was then taken, when the 21 members present all voted for the scheme, and this being a clear majority of the Council the scheme was declared carried. The Mayor announced that the Bill would proceed in Parliament.

Kingston.—Councillor Collings, in moving the approval of the minutes of the Lighting and Market Committee at the Town Council meeting, said he was disappointed at the last meeting of the Council, when some members of the committee were absent and one member apparently altered his mind in regard to one item of business, in consequence of which the recommendation of the committee was not accepted by the Council. He said then as he said now, that if that represented the policy of the Corporation he could no longer act as chairman of the committee. He wished the members to understand that they could not stop in this electric lighting undertaking. There were two courses open to the Corporation, but the third one of stopping was not open, and could not be open. For instance, only on Saturday evening the electrical engineer came to him and asked for permission to give certain orders to Messrs. Siemens for additional cable which was necessary for the purpose of making connection to two or three properties. There was first of all an application from the owners and occupiers of some new shops in Fife-road, and to supply them the cable must be extended from the entrance to White's factory in that road. Then there was an application from Mr. Edgell, the clerk to the Guardians, for the light to be laid on to the offices of the Guardians, which also required more cable. Again, it was about settled that St. Raphael's Roman Catholic Church would be lighted with electricity by the Countess of Mexborough, for which also cable was needed. The electrical engineer said the cost of the cable he wished to order would be £50 or £60, but in the present temper of the Council he did not feel disposed to take the responsibility of sanctioning the outlay. From September 1 to the present time they had received applications for connections representing 990 additional lamps. The number already fixed and applied for was 6,740. Mr. Preece told them a long time ago that the installation in its present condition was only adapted for 7,000 lamps, and they were already within 260 of that number. But Mr. Preece, in giving his estimate of 7,000, calculated that the average number in use at one time was only half the number of lamps fixed. But so large a proportion of those in Kingston were shop lamps that considerably more than half were running at one time. Therefore they were in the position that the machinery they had was only barely adequate to the present demand, and before they could go on connecting up new customers they must face the necessity for the provision of a new machine, engine, and boiler, and consequent extension of the engine and boiler house. He moved the approval of the minutes, and he hoped that would carry with it sooner or later that which he thought was its only logical outcome—an increased salary to the borough electrical engineer, and a further expenditure of capital necessary for the extension of the works, in order to meet the demands for the light created by the very success of the works. Councillor Salmon seconded, and deprecated the idea of selling the undertaking to a private company now that it gave every promise of success. It might cost £50,000 or £60,000, but by that time he had no doubt it would be a thoroughly paying concern. The motion was carried after a brief discussion.

Croydon.—A Local Government Board enquiry has been held by Mr. G. W. Willcocks into the application of the Town Council to borrow £10,000 for the electric lighting of the borough under the Electric Lighting Act of 1882. There was no opposition. The Town Clerk read the resolution of the Council on April 27, 1896, and stated that the amount required was divided into two distinct sums of £5,000 each. The first was made up of extras on the original estimate, certain works having cost more than they estimated for. Additional plant and additional works had been found necessary on that account. The additional plant put up included an expenditure of £2,675 for arc lighting, that being for the lighting of the streets in the centre of the borough, and £1,250, the cost of the land on which the central station was built. This land was exactly three acres, was situated in Factory-lane, and was purchased freehold. The reason that the amount for this land was not included in the original estimate was that the Corporation were already owners of land in Factory-lane, which they thought they could utilise for the purpose, but subsequently found that they must retain this land for the purpose for which it had been originally acquired—viz., for allotments and roads depôt. He said nearly the whole of the amount of this work was now in hand, and the reason why they had not applied to the Board of Trade for this amount before was that these were absolutely essential extras for the proper equipment of the scheme. It was almost impossible to know what the cost would be until it was completed. It was necessary that if the arc lamps were to be obtained by the burgesses during the ensuing winter that they should be proceeded with without delay. There was an advantage in giving the contract to the present contractors, and it was more advantageous to arrange the contract in the summer rather than to wait for the winter. If the enquiry had been held a fortnight earlier the arc lamps would not have been completed. The other £5,000 was the estimated sum required to carry out extensions to portions of the district outside the compulsory area. These extensions were requisitioned by burgesses who required to have the light. Alderman Miller, the chairman of the Electric Lighting Sub-Committee, said he had been a member of the Council since the incorporation of the borough in 1883. On November 20, 1895, the Local Government Board sanctioned the borrowing of £27,500 for the purpose of lighting the borough with electric light. The station could not have been worked unless the additional sums had been spent when they were spent. They had 50 applications for the supply of light within the compulsory area, representing an equivalent of 5,089 lamps. These applications had been received within the last four weeks. About 28 applicants only had been connected up. He had had verbal applications for another 1,000 lamps. The original estimate included the laying of no

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mains outside the compulsory area, and that was the most desirable part of the town to lay the light in. There would be a guarantee of at least 10 per cent. from those who wished to benefit by the extensions to cover a portion of the cost of laying the mains Prof. Kennedy, consulting engineer said he prepared the original estimate of £27,500, and also the supplementary estimate. There were 40 arc lamps to be supplied, and 40 posts were required to carry these. He produced plans to show how these were to be placed. These were obtained at contract price, and the cables were purchased at schedule price, at so much per yard. The water for the central station would be brought from the River Wandle by means of pipes laid through the recreation and allotment grounds. It was expected that the central station would be much nearer the Wandle than it actually was. They did not intend to carry out any of the extensions without the guarantee. Formal evidence was then taken, and the enquiry concluded.

PROVISIONAL PATENTS, 1896.

NOVEMBER 9.

25079. Improvements in and in connection with conduits and collectors for electric tramways and the like. Charles Herbert Gadsby, 102, Park road, Loughborough.

25121. Improvements in locking gear for electrical switches. Louis Frank Awde, 19, Fleet-street, London.

25123. Improvements in incandescent electric lamps. William Aubert, jun., 22, Southampton-buildings, Chancery-lane, London.

25126. Improvements in arc lamps. Alexander Pflüger, 37, Chancery lane, London.

NOVEMBER 10.

25143. Improvements in or relating to electric arc lamps. Richard Joseph Crowley and Edward Burton Payne 104, Colmore row, Birmingham.

25170. Loud-speaking long-distance telephone. Paul de Kilduchevsky, 53, Chancery-lane, London.

25214. Improvements in electric light arc lamps. Andrew Casey, 18, Fulham place, Paddington, London.

25234. Multiple fuse block and switch. Edwin Heber Montgomery and Mathias Thommes, 46, Lincoln's-inn-fields, London. (Complete specification.)

25242. Improvements in electrical discharge apparatus. Reginald Belfield, 322, High Holborn, London. (Alexander Jay Wurts and Charles B. Skinner, United States)

25251. Improvements in or connected with incandescent electric lamp fittings. Albert Vandam and Frederick Harrison 47, Lincoln's-inn-fields, London.

NOVEMBER 11.

25290. An electric light meter. John Francis de Bauw, 9, New Broad-street, London (Complete specification.)

25293. Improvements in combined motors and electric generators. James Atkinson, The Woodlands, Marple, Cheshire.

25323. Improvements in electric motor regulators. William Arnold-Anthony, 36 Chancery-lane, London.

25343. An improvement in electric locks for railway point and signal levers. Edward Tyer, 28, Southampton-buildings, Chancery-lane, London.

25345. Improvements in communicating electrical energy to vehicles and apparatus for that purpose. Siemens Bros. and Co., Limited, and Alfred Mills Taylor, 28, Southampton-buildings, Chancery-lane, London.

25346. An automatic brake for an electric motor. Siemens Bros. and Co., Limited, and George Sylvester Grimston, 28, Southampton-buildings, Chancery-lane, London.

25360. Improvements relating to the coating, covering, or amalgamating of metals with metals and of any other substances with metals and other materials by the aid of electricity, and to apparatus therefor. Frederick Hall Snyder, 11, Southampton-buildings, Chancery-lane London. (Complete specification.)

25365. An improved electrode for secondary batteries. Henry Woodward, 53, Chancery-lane, London.

25370. Improvements in electric incandescent lamps or their connections or holders. Frederick Roberts Pope, 6, Lord street, Liverpool.

NOVEMBER 12.

25481. Improvements in electric pendants. Heinrich Kray, 40, Chancery-lane, London.

25482. Improvements in or relating to induction coils. Stanislaus Szubert, 40, Chancery-lane, London.

NOVEMBER 13.

25500. Improvements in or connected with electric lampholders, sockets, and the like. John Benjamin Verity, Plume Works, Aston, Birmingham.

25541. Improved vibration brake-spring for gas, electric, or other lighting. George May, 5, Hanover-street, London.

25560. Improvements in or relating to electric arc lamps or lighting apparatus. John Smith, 11, Southampton-buildings, Chancery-lane, London,

25577. Improvements in electrical transmitters and indicators for indicating and recording motion. Robert Mann Lowne, 23, Southampton-buildings, Chancery-lane, London.

25601. Improvements in the cells or boxes of electric batteries. John Miles Moffat, 11, Southampton-buildings, Chancery-lane, London.

NOVEMBER 14.

25631. Improvements in the means employed in the electrolytic production of the chlorates of sodium and potassium. Thomas Parker, Prince's-chambers, Wolverhampton.

25644. Improvements in type-printing telegraphic apparatus. Frederick Herbert William Higgins, 18, Southampton-buildings, Chancery-lane, London.

25652. Improvements in Gramme ring armatures. Roslyn Holiday and John Freeman, 3, Burlington-arcade, Barnsley.

25701. Improvements in or connected with secondary batteries. Joseph Horsnell May and Frank King, 47, Lincoln's-inn-fields London.

SPECIFICATIONS PUBLISHED.

1895.

22450. Incandescent electric lamps. Burnet.

22686. Automatic electromagnetic interrupter for protecting electrical installations. Abel (Compagnie pour la Fabrication des Compteurs et Materiel d'Usines à Gaz).

23670. Methods of lighting by electric arc lamps. Guérin.

1896.

1144. Electrodes for electrolytical purposes. Heraeus.

1237. Electric incandescent lamps. Robertson.

2197. Telephones. Imray. (La Société Anonyme pour le Transmission de la Force par l'Electricité.)

12250. Plates for secondary galvanic batteries and a method of producing the same. Marschner.

15129. Process and apparatus for effecting electrolysis. Golby. (Arlt.)

19301. Storage batteries. Preiss.

20796. Electric railways. Lake. (Lundell.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	7½-8
Brush Company, Ordinary	3	¾-1¼
—— Non. Cum., 6 per cent. Pref.	2	1-1½
—— 4½ per cent. Debenture Stock	100	110-113
Central London Railway, Ordinary	10	10-10½
——	2	4-4½
Charing Cross and Strand	5	9½-10
Chelsea Electricity Company	5	7¾-8¼
—— 4½ per cent. Debentures	100	114-117
City of London, Ordinary	10	16-17
—— 6 per cent. Cumulative Pref.	10	16½-17½
—— 5 per cent. Debenture Stock	100	130-135
City and South London Railway, Consolidated Ordinary	100	52-54
—— 4 per cent. Debenture Stock	100	135-137
—— 5 per cent. Pref. Shares	10	15-15½
County of London and Brush Provincial Co., Ordinary	10	8-9
—— 6 per cent. Cum. Pref.	10	13¾-14¼
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
Edison and Swan United Ordinary	3	1¾-2¼
—— 4½ per cent. Debentures	100	103-106
Electric Construction, Limited	2	1¼-1¾
—— 7 per cent. Cumulative Pref.	2	2½-3
Elmore's Copper Depositing	2	¼-¾
Elmore's Wire Company	2	¼-½
W. T. Henley's Telegraph Works, Ordinary	10	17-18
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	109-114
House-to-House Company, Ordinary	5	3¾-4¼
—— 7 per cent. Preference	5	8¾-9¼
India Rubber and Gutta Percha Works	10	20½-21½
—— 4½ per cent. Debentures	100	105-108
Kensington and Knightsbridge Ordinary	5	9½-10
—— 6 per cent. Pref.	5	8¼-8¾
Liverpool Electric Supply, Ordinary	5	8-8½
Liverpool Overhead Railway	10	13⅜-13⅝
—— 5 per cent. Pref.	10	17⅛-17⅜
—— 4 per cent. Mortgage Debentures of £100	100	112½-114½
London Electric Supply	5	⅞-1⅛
Metropolitan Electric Supply	10	13-14
—— 4½ per cent. First Mortgage Debenture Stock	100	121-124
National Telephone, Ordinary	5	7⅛ 7⅜
—— 6 per cent. Cum. First Pref.	10	17-19
—— 6 per cent. Cum. Second Pref.	10	17-19
—— 5 per cent. Non. Cum. Third Pref.	5	6¾-7
—— 3½ per cent. Deb. Stock	100	105-108
Notting Hill Company	10	9½-10½
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8¾ 9¼
—— £4½ shares	4½	7¼-8¼
Oriental Telephone and Electric Company	1	¾-⅞
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	103-105
Southampton Electric Company	5	4¾-5¼
St. James's and Pall Mall, Ordinary	5	12-13
—— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	39-42
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	—	7¾-8¼
Westminster Electric Supply, Ordinary	5	10½-11½
Yorkshire House-to-House		7½-8

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NOTES.

Science on the Plate River.—The Argentine Scientific Society, to which, says the *Boletin de la Unión Industrial*, the country owes thanks for many good services, intends to celebrate its fiftieth anniversary by holding a "Latin-American" scientific congress at Buenos Ayres

New Edition.—We have received from Cassell and Co. vol. i. of the new, revised, and enlarged edition of Prof. W. E. Ayrton's "Practical Electricity." This is the second issue of the rewritten edition of 1896, and we hope to notice further some of the new features shortly.

Chesterfield and Midland Engineers. — The Chesterfield Institution is to join the Midland Institute of Mining, Civil, and Mechanical Engineers in their excursion to the South Carr borings at Idlestrop, near Doncaster, to-morrow (Saturday). The party leave Doncaster by the 2.10 train.

American Publications for Europe.—From the *Street Railway Review* (Chicago) we have received a type-written letter, marked "dictated to phonograph," to say that the *Review* is going to start a regular foreign edition. It will come out quarterly, and the Americans being before us in the adoption of electric tramways, it is supposed that what they have done and are doing will not be without interest to European workers in the same field

Rail Wear.—The American *Engineering News* wants to know why an electric car should be more severe on the rails than a steam locomotive ? The first question we should be inclined to ask is, Is it ? And our contemporary is by no means certain as to how the question should be answered. "Perhaps the fact that on a railway in a paved streets the joints are let alone until their condition becomes so bad as to compel the removal of the paving to make repairs has something to do with the troubles experienced."

The Cantor Lectures.—The first of the Cantor lectures of the season at the Society of Arts, Adelphi, was given on Monday night by Prof. Vivian B. Lewes. The subject of the course is the use of gas for domestic lighting. The lecturer referred to the improvements which have been made in the measurement of light during the last 50 or 60 years. The photometer now in use gave very fair results. But sperm candles, as the standard of illumination, had very grave defects; yet, though they had been the butt of all committees which had been appointed upon the subject, they were still with us.

Institution of Civil Engineers.—At the ordinary meeting on Tuesday, November 24, Mr. J. Wolfe Barry, C.B., F.R.S., the president, in the chair, a paper on "The Bacterial Purification of Water," by Dr. Percy Frankland, F.R.S., was read, in which the author dealt with the more important advances in the subject since he brought it before the institution 10 years ago. The paper is to be discussed next Tuesday. There will be a students' meeting on Friday, December 4, at 8 p.m. An address will be given by Mr. J. Wolfe Barry, C.B., F.R.S. (president), and a paper read on "Railway Signalling" by Mr. D. W. Kinnour.

Imperial Institute.—Prof. J. W. Judd, dean of the Royal College of Science, lecturing at the Imperial Institute on "Rubies, Natural and Artificial," said that the ruby retained its position as embodying the highest value in the smallest compass. So far as production was concerned this seemed likely to continue, but then the rage for rubies might not last. The natural gems might be superseded by artificial ones, for already small rubies, and, indeed, tiny precious stones of nearly all kinds but the topaz and the tourmaline, had been made. These will be a curiously humble couple to survive when all the rest are discarded, because everyone that wants them can have them.

Dundee Institute.—There being no exhibition of pictures in the art galleries this season, the council of the Dundee Institute of Architecture, Science, and Art has decided that there should be, instead of a conversazione, a dinner and "at home" on Thursday, December 10, at 6.30 p.m., in the Queen's Hotel, Nethergate. Mr. Leslie Ower, president, will take the chair. Arrangements have been made for the accommodation of members coming from a distance. The following are the fixtures for the session: December 17, lecture by A. M'Gibbon, "A Gothic Renaissance"; February 4, exhibition of drawings; March 18, lecture by J. A. Williamson; April 22, exhibition of drawings; June 30, annual business meeting.

Cable to Iceland.—The *Glasgow Herald* has published an interview with Dr. Jon Stefansson on the subject of a proposal for telegraphic communication with Iceland. Dr. Jon Stefansson, an Icelander by birth, a Dane by education, and for the present a resident in England, occupies his spare time as an unofficial ambassador in the interests of his native land. He holds strong views respecting the natural resources of Iceland and their remunerative possibilities. The Icelanders have been consistently patriotic since the time that Thangbrand got into trouble for denying that Iceland is the fairest land that the sun doth shine upon, but a bad soil and a worse climate do not hold out much hope for business enough to warrant a cable. Reykjavik market reports will hardly keep it going.

The Pacific Cable.—According to news received at New York from Honolulu, the Hawaiian Government has rejected a petition to extend for a year the option of Mr. Spaulding and his associates, which expires shortly, for the laying of a Pacific cable. Mr. Foster, former United States Secretary of State, is at Honolulu looking after the interests of the American Cable Company and Americans in general. Meanwhile our own Cable Conference has held another sitting, and doubtless is considering these and similar things. But as the conference has decided not to give the Press any information as to what it is doing and when the cable-laying is to be got to, it seems scarcely worth to make a note of it every time it is seen that Lord Selborne has met the Colonial delegates at the Colonial Office.

Scottish Engineers.—The second general meeting of the fortieth session of the Institution of Engineers and Shipbuilders in Scotland was held on Tuesday night in the hall of the Philosophical Society at Glasgow, Sir William Arrol, M.P., presiding. A paper by Mr. Alexander Morton on "The Maximum Elasticity and Density of Steam" was discussed. The premiums of books were awarded to Mr. J. M. Gale, M.I.C.E., and Mr. W. Carlisle Wallace for their respective papers on "The Extension of the Loch Katrine Waterworks" and "Electrical Transmission in Shipyards and on Board Merchant Steamers;" while Prof. W. H. Watkinson was the recipient of the award of engravings for his paper on "Water-Tube Boilers." Afterwards a paper by Mr. Sinclair Couper on "Internal Corrosion in Steam-Boilers" was read, and another was contributed by Prof. Archd. Barr, D.Sc., on "Some Lecture-Room and Laboratory Appliances."

Overhead Wires in Spain.—Regulations for electrical installations which make use of the public land—*i.e.*, are not confined to private property, but pass through streets, etc.—have been published in *Electron*. Copper cables must be used unless permission to use other metals is obtained from Government. Wires must be insulated unless the department responsible specially

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agrees to allow bare ones. Posts or supports must be of wood or iron unless the department allows them to be of some other material. The wires shall cross roads at a height of eight metres (say 26ft.) or more if circumstances require it in the judgment of the Ministry. The maximum distance between the posts shall be a hundred metres (say, 325ft.) but may be augmented to such an extent as the Minister thinks suitable. The insulators shall be of porcelain or some other material which in the judgment of the Minister produces the same result. That is all. There could hardly be less, and what there is can all be dispensed with by the Minister of the Interior, or whoever advises him. The erecters of overhead wires will doubtless consider them model rules.

Refining Plant.—A description of the electrolytic copper and silver refining plant of the Guggenheim Smelting Company at Perth Amboy, New Jersey, was given some time ago in the *American Electrician*. This plant has an annual capacity for about 10,000 tons of copper and 30,000oz. of silver. The copper cathode plates are electrolytically formed separately into thin shells and then placed in the regular copper-refining baths. The anodes weigh 275lb., and the electrolytic reduction of each requires about 24 days of 24 hours. The intensity of the current varies from seven to twenty amperes per square foot, the lower density being used with copper rich in precious metals. There are 360 tanks for copper refining, each containing 22 anodes in parallel. All the tanks are connected in series. The voltmeter at the switchboard registers from 117 to 120 volts, with 1,500 amperes. The Möbius process is used for silver refining. There are 48 silver-refining tanks, each of a capacity for from 600oz. to 700oz. of silver per 24 hours. Each tank has 24 anodes in parallel, and all the tanks are connected in series. The cathode consists of a silver belt which is always kept in motion and upon whose surface the silver is deposited from the anode and removed by scrapers located at one end of the tank. The surface of the belt is about ½in. below the lower surface of the cathodes and is made of a sheet of pure rolled silver 15in. wide, 31ft. long, and weighing about 40lb. Each of the anodes, which are 12in. by 3in. and 1in. thick, usually contains 100oz. of silver and from 3oz. to 8oz. of gold.

Forthcoming Events.—This (Friday) afternoon there is a meeting of the Physical Society at the rooms of the Chemical Society, Burlington House, at 5 p.m. (Captain Abney, F.R.S., on photographic shutters).—The Electro-Harmonic Society have a "Ladies' Night" in the evening (St. James's Hall Restaurant, 8 p.m.).—On Saturday, November 28, is the opening of the Brighton Seashore Railway; the arrangements are described in the "Business Notes." On the same day the Chesterfield Engineers and the Midland Mining Engineers have an excursion meeting at Doncaster. Monday, November 30, is the date of the anniversary meeting of the Royal Society at Burlington House, and the dinner at the Hôtel Métropole (7.30).—There is a students' meeting at the Institute of Civil Engineers, Great George-street, at 8 (Mr. Kinnour on signals), and on the same evening there is the second Cantor lecture at the Society of Arts (Prof. Lewes on gaslighting). On Tuesday, December 1, Major Flood Page addresses the London Chamber of Commerce on motorcarts (Botolph House, E.C., 3.30 p.m.). In the evening, the Institution of Civil Engineers have an ordinary meeting to discuss further the paper on "The Bacterial Purification of Water," by Percy F. Frankland, and at this meeting the monthly ballot for members will be taken. On Wednesday, December 2, at the Society of Arts meeting, Mr. W. A. S. Hewins, M.A., lectures on "The Teaching of Economics." Sir Owen Roberts will preside.—The Stanley Show begins at the Crystal Palace next Friday.

More "Electricity."—Certain facts which have come to the knowledge of the writer have shown him that the belief in the efficacy of the "dowsing" or divining rod for finding water is still much more widely spread than would be generally supposed, but the following, which is given in the words of a local contemporary whose reports are usually remarkably correct, is certainly surprising. The Marquis of Lorne was lecturing at Helensburgh on "Superstition," and after describing how the Highlanders had actually been so ignorant, even down to the time of Queen Anne, as to believe in the efficacy of charm stones, went on to deal with "water divination by means of the divining rod, and referred to many striking instances where the use of the twig had brought about the discovery of water in unlikely places. He was of opinion that it was quite within the bounds of possibility that the secret of the divining rod was to be found in electricity in the body of the expert striking down to the electrically charged water, although scientists would disclaim that water was charged with electricity. He had suggested the experiment of a receptive subject being led towards an electrical machine with the divining rod; and the subject, a young lady, being blindfolded, on being placed near to such a machine it was found that the rod immediately twisted round. Only one person in every five or ten thousand had the receptive power necessary for water definition." That the ordinary "educated" man should know nothing of the way the world works in which he lives is the fault of our system of education, but the lecturer in this case happens, among other things, to be the son of a duke who has laid claim to something more than a bowing acquaintance with science, and who is supposed to have studied the development of civilisation and the way in which erroneous beliefs originate. As to why people should prefer to assign anything they do not see the reason of to "electricity," rather than to medicine, heat, chemistry, kinematics, or anything else, that is one of the questions that seems likely to remain an insoluble mystery.

Boiler Explosions.—The report to the secretary of the Board of Trade on the working of the Boiler Explosions Acts, 1882 and 1890, has been issued. During the 12 months ending last midsummer 65 preliminary enquiries and 14 formal investigations were held under the provisions of the Boiler Explosions Acts. In 14 cases formal investigations were ordered, and in nine of these the owner or owners had to pay costs varying from £5 to £60. In one case the owner was killed by the explosion, and it was held that he had erred through ignorance in neglecting to have the boiler properly examined. That men who know better will "chance it" in a way not to be justified by pure reason seems always ignored. In the other cases no blame could be found with the owners or their servants. During the year under review 25 persons were killed and 48 were injured by boiler explosions which came under the notice of the Department, and out of the 79 cases dealt with 39 explosions occurred on board vessels and 40 on land, but these figures do not represent the relative proportions of explosions on land and explosions at sea. The opinion is expressed that, in view of the large number of steam-boilers in use in the United Kingdom, the percentage of cases in which the neglect shown was so great as to lead to a serious explosion was extremely small. The total number of cases attributed to the defective condition of the boiler or its fittings was 33, and of those due to the neglect or ignorance of

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the boiler attendants 14. It would be useful if the cases of neglect were discriminated from the cases of "ignorance," though that is not by any means always possible. Moreover, there are boilers and boilers, and what are called by the Board explosions differ widely in their character and effects. If it should be shown that when certain classes of boilers go the destruction is widespread, while with others the damage is usually local and limited, the information would be valuable to many people. It is satisfactory to note that the report shows pretty clearly the hollow character of the contention that there would be an appreciable gain to public safety if boiler attendants were examined, certificated, and generally made a close trade of.

Motorcarts.—Mr. Harrington Moore has written to various papers to protest that there never was any race either from London to Brighton or back again. We never supposed there was, and therefore said little about the recorded "times." Nevertheless, it would appear beyond doubt that all motorcart owners have not been quite wise as to keeping always within the speed limit. From a business point of view it would be advisable for motorcarts to exhibit their ability in getting out of the way of other vehicles rather than to insist on their strict rights, or to blow a horn as though they expected everyone to clear the way before them. When people realise that they can be stopped quickly, they will cease to fear them. At present the popular mind is infected with ideas on the subject derived from the railway train. Mr. Ward's electric omnibus has been tried at Charing Cross, but the trial was not a success. It is stated, however, that this was the result of some foul play on the part of someone in charge of the yard. A lady has suggested that in building motor carriages the old lines of the horse-drawn vehicle should be abandoned, not followed. The writer is inclined to think so, too, but cannot go quite so far as Miss (or Mrs.) E. F. Fleet's motor "swan," which would be out of place anywhere but in a circus procession. The Queen of Spain is to have a motor carriage driven by Mr. Julian's batteries. News of some authentic trials of those batteries, with details of the length of run and its cost, would be more welcome to us. The *Liverpool Daily Courier* has burst into verse on the new means of locomotion. There are ten stanzas; we have only space for the last:

"To say that we've got to the top
Of invention is utter futility!
At Ubiquity only will stop
Electro-pan-Auto-mobility!"

Much is pardoned to the poet, even the last word, but the game which we thought played out of inventing new names for motorcarts has been started again. Mr. Sibley wants them called "autokinouns." The Greek of this is questionable, and according to the ordinary way of transliterating it would be "autocinun" in English. The Society of Arts discussion is the subject of another note.

Telegraphs in the Himalayas.—The report of Mr. Olphert, of the Kashmir Division of the Indian Government Telegraph Department, has been referred to in the *Bombay Gazette*. The report covers the past five years of his work mainly among the mountains of north Kashmir, and is one of many hardships and narrow escapes endured with great fortitude. In laying a line in the winter of 1892-93, between Srinagar and Kohala, Mr. Olphert was at Uri with his working party when the snowstorm commenced, and the snow lay nearly 3ft. deep on the ground when it stopped snowing. The party were in tents at the time; most of the tent ridgepoles were broken by the weight of snow, the cold was intense, and the coolies would not move. They said they would all die, and Mr. Olphert had to march the party down to Kohala by a road cut through conglomerate cliffs in many places, and with the stones in these cliffs, loosened by the frost and snow, falling out all day long on to the road below. They had to face the same danger coming back, but got into Srinagar without accident. The Kashmir officials "showed great appreciation of the work so long as it put them to no particular inconvenience." But when 8,000 coolies were applied for [one may, however, consider the feelings of a coolie asked to do work like the foregoing] to carry telegraph poles, only 50 were supplied, and the work was in consequence most disastrously delayed. The Kashmir coolie is superstitious, and if he believes an undertaking unlucky he will do his best to secure the fulfilment of his dreams. Mr. Olphert's men had a strong belief that a telegraph line could never be got over the Burzil Pass, and looked for the fulfilment of the prophecy, so the utmost difficulty in keeping them together was experienced. Work in Gilgit was also attended with great difficulty, but it was accomplished, and a line which was broken down five or six months every year is now replaced by one of decent permanence. When Mr. Olphert set to work he was assured on all sides that no aerial telegraph line could possibly stand on the passes, and he was strongly advised to lay a cable. All difficulties were, however, surmounted, and it has been proved possible to maintain telegraphic communication across the Kashmir passes in the very worst weather.

Forced Draught.—Now and again someone starts off to consider the difference between the interest on the capital expended in building a chimney shaft and the cost of the steam necessary to produce a forced draught. For examples of how it works in practice one would naturally look to America, where the traditions of permanency in building are less strong. Of course, it is where the demand for steam is intermittent that the advantage of a forced draught comes in. The following from a paper read before the American Street Railway Association by Mr. R. McCullough gives an idea of what is being done in the States in this direction. Much has been written about the electric locomotives in the Baltimore and Ohio Railroad's tunnel, but, so far as the writer knows, the way the boilers are worked in the power-house is new on this side of the Atlantic. Mr. McCullough says several of the large power-houses built during the last few years have abandoned the use of stacks for producing draught, and are operating by means of an induced draught produced by fans placed in the flue or short stack. In this case the stack is just high enough to clear the roof. This system has many advantages. First, there are no stacks to blow down or fall down, and this point is of special importance in a region subject to tornadoes. The second and most important advantage, however, is the absolute control which it affords in governing the fires, and this point will appeal especially to those power-houses subject to sudden and rapidly changing loads. As an illustration of this may be cited the power-house recently erected to operate the Belt Line tunnel road, in Baltimore, Md. A great part of the time there is no load on the power-house, as it is only operated when there is a freight train to be hauled through the tunnel. The manner in which the load is handled is as follows: The boiler-room is supplied with blowers in place of stacks, and a slow fire is kept constantly under each boiler. When a telegram is received that a freight train is approaching, the blower is started, and, on the arrival of the train, steam has been raised in sufficient quantity to supply the great demand put upon the boilers. This illustrates the extreme flexibility of the system, and it would be difficult to handle this load in any other manner. Economisers are operated with great efficiency in connection with an induced draught, as this system permits the flue gases to be robbed almost entirely of their heat, since it is not

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necessary to have a large quantity of heat in the flue gases in order to create a proper draught.

Physics and Engineering at Glasgow.—The temporary laboratory which is being equipped for the use of the engineering department of Glasgow University pending the erection of new buildings was opened this week. A prominent part of the apparatus is a Crossley gas-engine of about 10 h.p., presented to the university by the committee of the Murdoch Memorial Fund, under the auspices of the North British Association of Gas Managers. The engine drives a dynamo which will supply current to a battery, and the installation will be used for the lighting of the laboratory as well as of the Bute and the Randolph halls by electricity. It will also drive an electric motor to provide power for the working of machinery to test the strength of metals. When the engineering laboratory is built, the engine will be given a permanent place there in connection with the generation of power. At the ceremony on Wednesday afternoon, which took place in the university court-room, there were present, among others, Principal Caird, who presided; Lord Kelvin, Sir William Arrol, M.P.; Prof. Jack, Prof. Barr, Prof. Byles, Mr. Andrew Stewart; Messrs. A. Bell, Dalkeith, and Dr. J. T. Bottomley, and others. In the course of the proceedings, Lord Kelvin said that, as Principal Caird had just pointed out, Murdoch had done great things for the whole world; and now, about 100 years after Murdoch introduced gas, its use for lighting was being largely superseded. The engine would be a perpetual memorial that gas had not completed its work, that it had done all that could be done in the way of lighting directly, but that it was now largely used for driving machines which produced lighting by electricity. He thought that the North British Association of Gas Managers might be very happy indeed in their prospects. Gas was doing more than ever it did in the way of lighting. It was likely to be more largely used as a motor, and however much might be done by electricity, he saw nothing but prosperity and augmented work for the gas manufacturers of the United Kingdom, and he might say also for the world. Prof. Barr, as representing the engineering department of the university, thought it was not at all inappropriate that a memorial of Murdoch should take the form of an apparatus which was more or less for the purpose of superseding gas as an illuminant. Murdoch was one of those characteristic inventors who was never satisfied with anything that was attained. Prof. Barr added that they were that day practically opening the small and temporary laboratory; but as the funds for the permanent laboratory were now available, he hoped the university court would in the very early future fix definitely on a site for the new buildings, and allow them to get forward with the erection of them.—The opening meeting of the Physical Society of Glasgow University took place last Friday night in the natural philosophy classroom, when the president (Dr. Magnus Maclean) gave his presidential address, choosing as his subject Röntgen rays, or, as he remarked, some of the physical and visible phenomena occurring on passing an electric discharge through gases at different densities from ordinary density down to the lowest we can obtain by the best mechanical means at our disposal. A large audience filled the lecture-room, and on the motion of Lord Kelvin, seconded by Dr. Macintyre, Dr. Maclean wa awarded a very hearty vote of thanks.

Yorkshire Student Engineers.—Last Saturday evening the third annual dinner of the Association of Yorkshire Students connected with the Institution of Civil Engineers was held at the Queen's Hotel, Leeds. About 60 gentlemen were present, including Mr. Arthur Greenwood (president), Mr. W. H. Preece, C.B., Mr. W. E. Garforth, Mr. A. T. Walker (vice-president of the association), Mr. E. R. S. Escott, Prof. Goodman, Prof. Grover, Prof. Ripper, Mr. J. McLaren, and Mr. Henry McLaren. There was a toast list of the usual kind, but what followed was more like a discussion on technical education. In proposing "The President and Institution of Civil Engineers," Mr. Walker observed that Lord Rosebery had lately proved to his own satisfaction that the Germans were very much ahead of us. Mr. Balfour had declared that we were very much behind in our understanding of the relations of science to industry. They all respected and admired Mr. Balfour very much, and he was delighted to find that after visiting one of the principal works in Sheffield Mr. Balfour modified his opinion and remarked that he was almost sorry for what he had uttered on that subject. Mr. W. H. Preece responded and alluded to the rapid growth and development of the Institution of Civil Engineers, which now had 6,907 members. They were all bound together by one universal principle—the principle of energy. One thing that helped to keep the institution together was the establishment of local associations such as their own, which, he understood, now numbered 298 members. Alluding to the advantages which students could gain by visiting engineering and other establishments, Mr. Preece observed that the Post Office authorities had tried their very best to make the new establishment in Leeds up-to-date, and however much they might have erred in telephone work—according to the newspapers—they had in Leeds a post office which was doing what no other post office in the world had done up to the present. In Leeds they were driving their pneumatic tubes by electrical power, and were even melting wax with the electric current. They had also made Leeds the centre of the whole telephone service of the country, so that telegraphically and telephonically it was becoming a most important centre. He so far agreed with Mr. Walker as to think a great deal too much was being made of the scientific advance of Germany and of the efforts the Germans were making to instruct their workpeople in technical matters. They had found in what way the English had beaten them in the past, and, like clever fellows, were trying to retrieve their mistakes. But it was not in technical education the Germans were beating us; it was in business habits—in enterprise. Everywhere he had found it was the commercial education of the Germans that was doing so much injury to our industry, and not their scientific abilities. In science and electrical developments we beat them hollow. In foreign markets where the German had the best of the Englishman, it was because he was better educated in commerce though not in science. If they wanted to impress technical education on manufactures they must start at both ends. The employer wanted just as much technical education as the workman, and sometimes a good deal more. Mr. E. R. S. Escott proposed "The Yorkshire Association of Students," and, in reply, the President said the primary object of the association was to give the Yorkshire students some of the advantages enjoyed by those who could attend the lectures in Westminster. Then there was more about technical education, Mr. Greenwood appearing to be in substantial agreement with Mr. Preece.

Society of Arts.—At the meeting of the Society of Arts on Wednesday evening Mr. W. Worby Beaumont read a paper on "Recent Developments in Mechanical Road Carriages." Sir Frederick Bramwell presided, and in introducing the lecturer said the subject was one in which he himself took an interest so long as 60 years ago. Mr. Beaumont's address was very long, and dealt with the

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various types of carriages brought out. It can, therefore, hardly be summarised here. He, however, began by expressing a well-founded regret that the absurd legislative restrictions against travelling on public roads by mechanical means had so long been retained in this country. The result was that everything towards the construction of light motor vehicles had now to be commenced, while for a foreign trade other countries were now two years ahead of us. The new regulations had in general the assent of the motor-carriage building and using public, but there were some which were not defensible, in that they were of the nature of dictates to mechanical engineers on matters which they understood better than any outsider. On such structural details as reversing gear, brakes, and wheels they should be left to provide that which they, by past or coming experience, knew or would find to be best. The oil motorcart, particularly such as burned light oils, had come to the front in the trials up to the present, but Mr. Beaumont thought that was rather due to accidental and personal causes than to the inferior merits of the steam carriage. As to electric carriages, Mr. Beaumont dismissed them in a single sentence as simply a question of improvements in secondary batteries. The discussion that followed was interesting, some at least of the pioneers of the industry in the old days being present. Sir Frederick Bramwell began it. The idea of motorcarts had got a popular hold, and he thought it would run the usual course. There would be enthusiasm, premature work, a good many failures, some accidents, and the thing would fall into disrepute. Then it would be taken up again in a spirit of engineering, instead of one of company promoting, and it would be found that the method of locomotion was a valuable one. He was surprised to find that the pneumatic tyre would stand the wear and tear of traction work. Referring to the old days, Sir Frederick did not seem to think that engineers had made much advance in the matter during the long years of fallow. For his own part, had he the leisure and the money, he should like nothing better than to make a servile copy of Hancock's steam omnibus, which ran from Paddington to the Bank, and ask the present generation if they had done anything as good. The name of Mr. Walter Hancock was announced as the next speaker. This sounded alarming, but it was the nephew of the original Hancock. Mr. Sennett claimed for Perkins priority in many of the features of the Serpollet engine and generator. A sort of skirmish followed between Sir Frederick Bramwell and Mr. Sennett as to what Perkins's "tractor" was like. [A tractor is a sort of motor-thing that you tack on to a carriage to draw it instead of putting a horse in the shafts.] Ultimately Sir Frederick came out very much on the top, and it subsequently appeared that he had ridden behind the tractor and remembered all about it. It was a one-wheeled thing, in which the whole affair, including the boiler, went round. Mr. Terry spoke much, and Mr. De Vigne described his old "Fly-by-Night." The fault of this seemed to be that it was too heavy and went too fast for the nerves of our fathers and grandfathers. Moreover, it shocked the feelings of engineers by using steam at 150lb., or even 180lb. There seemed to be a general feeling that these old types might be consulted with advantage in designing new ones.

Technical Education.—At the Cutlers' Feast at Sheffield last week Mr. Arthur Balfour was the principal guest, and, in responding to the toast of "Her Majesty's Ministers," had something to say about the eternal technical education question. Mr. Balfour has suddenly become aware of the German expenditure upon technical and scientific instruction. A gentleman who has recently been visiting German institutions for training men in electrical science has told him that Germany has half a dozen of them, each better than anything we can show in this country. Also, the action of the State and the municipalities has been worthily seconded by German manufacturers, who spend large sums on research and keep large staffs of trained chemists and physicists engaged in work not directly profitable. The result is that he appears to have become a convert to the view that the smallest hint in developing any discovery, however slight, and making any advance, however small, may be of value. It was necessary, he said, to consider whether the example was not worth following. The idea that what is called technical instruction, by which was meant manual instruction, however good in itself, had anything whatever to do with the broad kind of education of which he was speaking, was quite as fallacious as the suggestion that education in the first three standards, leading up to the highest university training, was comparable to the manual education of which he spoke, and the technical education which he desired to see carried on. Elementary education was necessary to university education, but while education in the three R's led to knowledge, manual education, known as technical education, had really no connection with the scientific education to which he referred. He feared it might be said in some quarters that the relation between science and manufacture had not been thoroughly grasped. There might be some who still thought that the money spent upon abstract investigation was far removed from the practical needs of life, and that such abstract investigation had a very small effect on the well-being of the national commerce. He believed that those who held that view were profoundly mistaken. They had not followed the course of human knowledge or kept abreast with human progress. We had to learn a lesson which had perhaps come very easy to the Germans, but we ought at all events to learn it completely, and if we did that we should continue to hold that position which we had hitherto held unchallenged for British commerce and British industry, and we should be able to continue to claim throughout the world the supremacy which we had so long enjoyed and so well earned. As it is pretty well understood that the speaker is one day to govern this country, his conversion to something more than a philosophic doubt of the all-sufficiency of classics and literature for men of culture, and manual training for mere mechanics, may ultimately bear very practical fruit. There has also appeared a very characteristic letter in the *Times*. The anonymous correspondent applauds Mr. Balfour, but shows a complete inability to understand the importance and extent of both abstract and applied scientific knowledge, for he points with an air of conviction to the "instruction in science subjects and subjects of practical utility given in our evening continuation schools" as supplying the want to which Mr. Balfour calls attention. It will be seen from another note that Mr. Preece and others at an engineering students' dinner have been pointing out a view of the matter which might have been pressed home even more strongly. Mr. Preece says, in effect, that if the business man gets beaten by the Germans it is because he does not understand business, and not because he cannot get technical assistance. The business man assuredly does not understand the meaning of the technical education for which he is calling out. Mr. Preece's view is worth careful consideration, but worse than the business man is the irresponsible amateur who knows neither science nor business, and, as he is often found in very high places, he manages to decide how the money available for education shall be spent.

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RAILWAY BLOCK SIGNALLING.

BY J. PIGG.

(Continued from page 571.)

SINGLE LINES.

Another form of instrument in extensive use for single line work is Tyers's tablet instrument, three varieties of which are shown by Figs. 92-95. The electrical connections for the respective instruments are shown by the diagrams Figs. 92A, 93A, and 95A.

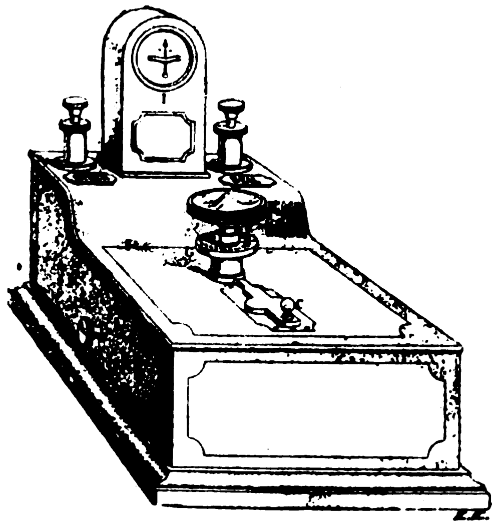

FIG. 92.

The "tablet," which constitutes the authority to proceed through the section, is usually an annulus of metal appropriately numbered and lettered in accordance with the section it is intended to represent. The tablets are placed in suitable receptacles in the body of the instrument, and the arrangement of the mechanism is such that only one

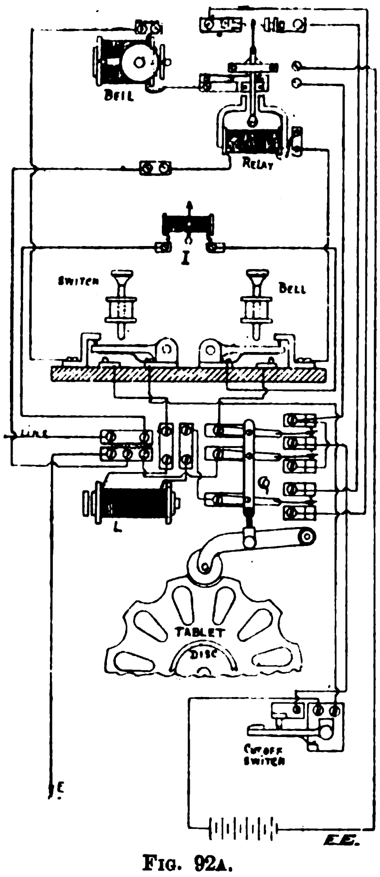

FIG. 92A.

tablet can be out at one time, and this removal can only be made after certain conditions have been complied with.

In the instrument shown by Figs. 92 and 92A the tablets are inserted in radial slots cut in a rotating disc, the motion of which is controlled by a pawl and ratchet wheel, the pawl in turn being operated by the locking electromagnet. The rotation of the tablet disc is effected by turning the knob, K, and movement of the disc actuates the commutator, Q, shown in Fig. 92A. The instrument is also provided with an indicator, I, a bell plunger, a switch plunger, a bell, a relay, and a small cut-off switch shown at the bottom of the diagram. Tablets are inserted or withdrawn at the opening covered by the cap, C (Fig. 92). The operation of withdrawing a staff, at A say, is carried out

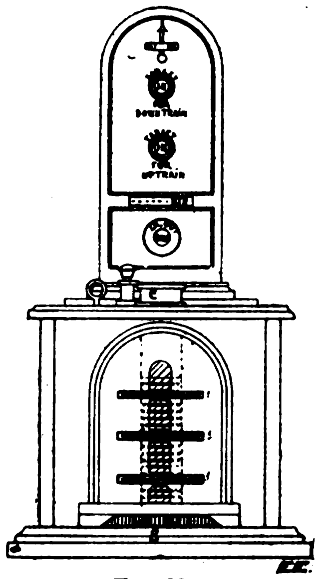

FIG. 93.

as follows, after the usual bell signals have been exchanged. A grasps the knob, K, and turns it as far as possible from left to right, and depresses the switch plunger, S. At the same time B depresses his bell plunger. Under these combined operations A's instrument is unlocked, and by turning the knob, K, from right to left he is able to bring a tablet into position under the cap, C. It is then only necessary to raise the latter in order to remove the tablet. The lifting of the cap, C, mechanically locks the rotating disc, so that

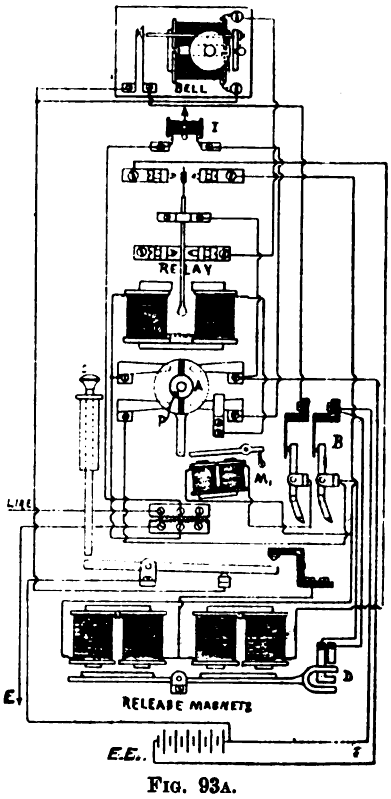

FIG. 93A.

only one tablet can be removed at a time, and this lock is only removed by placing C in its original position, when, of course, the instrument is again locked by the pawl and ratchet wheel.

Consideration of the diagram of connections will show

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that the depression of S at A during the operation of unlocking the instrument at that place, simply provides a path for the local current set in action by the upper tongue of the relay making the proper contact for the completion of the local current through the locking magnet, L. As shown in Fig. 92, the proper point of contact is on the left relay. The current from the distant station, B, due to the depression of the bell plunger at that place, simply passes through the indicator and relay, but the actuation of the latter for the purpose of unlocking L, in conjunction with the simultaneous depression of S, depends upon the direction of the current sent from B. The direction of this current is controlled by the commutator, Q, and a glance at Fig. 92A will show that the release of either instrument depends upon the commutator occupying similar positions at both places.

Provision is made for disconnecting the local battery whenever a tablet is immediately under the cap, C. This is done by the tablet, when in position in the rotating disc, depressing the cut-off switch shown at the bottom of Fig. 92A. No signals can be sent under these circumstances, and for this reason it is necessary to turn the knob, K, from left to right after a tablet has been inserted before the clearing line or arrival signal can be sent to the rear station.

With this form of tablet instrument a tablet may be returned to the instrument from which it was taken, and

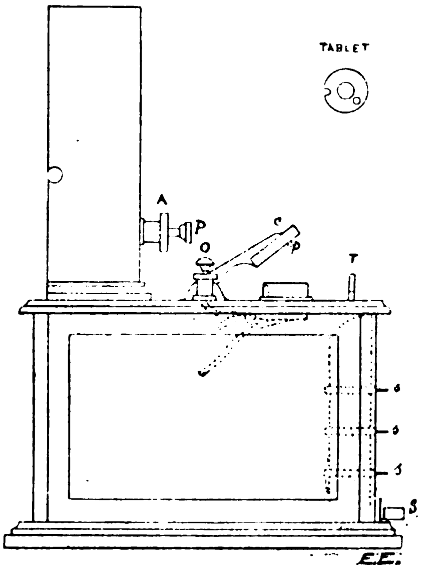

FIG. 94.

a tablet may therefore be withdrawn for local shunting purposes, involving use of part of the staff section only, without the necessity existing of conveying it to the opposite end of the section. One feature of this form of the tablet instrument is the absence of any indication of the condition of the line.

Figs. 93, 94, and 93A show another form of the tablet instrument. In this form tablets are inserted by raising the cap, C (Figs. 93 and 94), and withdrawn by pulling out the slide, S, at the bottom of the instrument. The tablets are contained in a hollow column above the slide, the lowest tablet fitting into a recess in the slide, and having its upper surface flush with that of the slide. A number of auxiliary slides, *s*, are provided to assist in supporting the tablets, which are lowered into the bottom slide as necessity arises. The positions of the tablets are visible from the front of the instrument, so that the approximate number available for use at any time may be observable in order that any transference of tablets rendered necessary by unbalanced traffic may be made in time to prevent delay. The bottom slide cannot be withdrawn from the instrument unless it contains a tablet.

The means used for preventing a tablet for one section being put into the instrument for another section are shown in Fig. 94, in which the cap, C, is shown raised for the insertion of a tablet. A radial slot is cut in the tablet, which, when the latter is put in the receiver fits into a projection for it, and necessitates the tablet being placed in one particular position when in the receiver. In addition to the slot, a small hole is formed in the tablet into which the pin, *p*, shown on the cap, projects. This pin must pass through the hole in the tablet before the cap can be placed down, which must be done before the lower plate on which the tablet rests can be released. By forming the hole in the tablet at different points relatively to the slot, and fixing the pin, *p*, on the cap in positions to suit, any tablet other than one intended for that instrument will prevent the cap from being placed in the position necessary to release the lower plate or receiver. When the cap is in its position for releasing the receiver the weight of the tablet depresses the lower plate, and the tablet falls off it and falls into the column shown by the dotted lines in Fig. 94. The locking shown between the cap, C, and the receiver plate is diagrammatic only.

The electrical part of the instrument is shown by the diagram Fig. 93A. It consists of a two-part commutator, bell plunger, relay, indicator, bell (which also acts as a relay), unlocking plunger, electromagnetic commutator lock, slide-releasing magnets. The operation of releasing a tablet is very similar to that described in connection with the instrument shown by Fig. 92. The switch, O, is depressed at the station at which the tablet is required, and the bell plunger is depressed at the distant station. The current from the distant station simply actuates the relay and indicator, and the former, in conjunction with the unlocking switch, provides a path for a local current through one or other of the releasing coils. A second local current is set up by the plunger attached to the bell armature, which passes through the electromagnet controlling the commutator. The withdrawal of the slide breaks the two spring contacts at B, and these remain broken during the whole time the slide is out. One of these contacts breaks the circuit through the commutator electromagnet, M_1, and the other contact breaks the battery circuit to the commutator and the bell plunger. An auxiliary circuit, however, is provided at D for the latter, and is closed by the armature of the releasing electromagnets. The lower indication "in" "out" is actuated mechanically by the turning of the commutator at that place; the upper indication is operated by the current, sent from the distant station, through the relay, after the commutator has been turned from its normal position.

The construction of this instrument is such as to prevent a tablet being returned to the instrument from which it has been taken. The tablet must be taken to the opposite end of the section. It cannot, therefore, be used for local purposes only.

(To be continued.)

THE PRINCIPLES OF ALTERNATE-CURRENT WORKING.*

BY ALFRED HAY, B.Sc.(EDIN.), A.I.E.E.

(Continued from page 570.)

102. When two circuits are so placed relatively to each other that a current flowing in one of them produces a magnetic flux through the other, we say that there is *mutual inductance* between the circuits. For example, if we have two coils of wire, A and B (Fig. 72), one of which, A, may be connected to a battery, and the other, B, is permanently connected to a galvanometer, G; then by closing the circuit of A we poke a certain number of lines through B, thus giving rise to an induced E.M.F. in B and (since the circuit is closed) current through the galvanometer. The current is, of course, only momentary, and ceases as soon as the current in A has become steady (Art. 23). If the circuit is now broken, the lines due to the current in A are removed from B, and we get a momentary deflection of the galvanometer in the opposite direction.

By altering the position of B, we can increase or diminish the galvanometer deflection due to the making or breaking of the circuit A. In particular, a number of positions may

* Based on a series of evening lectures delivered at the University College, Liverpool.

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be found for which there is *no deflection* when the circuit A is either made or broken. It will be found that in such positions the planes of the coils are mutually perpendicular, as shown in Fig. 73. For any such position, the magnetic lines proceeding from A run in a direction parallel to the plane of B, and therefore do not thread themselves through B. Hence the starting or stopping of a current in A does not give rise to any induced E.M.F. in B. When this is the case, we say that the two circuits are devoid of mutual inductance.

103. In order to investigate the effects produced by the mutual inductance of two circuits, it becomes necessary to adopt a unit in terms of which this quantity may be measured. Before doing so, however, we shall prove the following important proposition :

If two circuits, A and B, are so placed relatively to each other that a current i in A gives rise to N lines through B, then a current i in B will give rise to N lines through A.

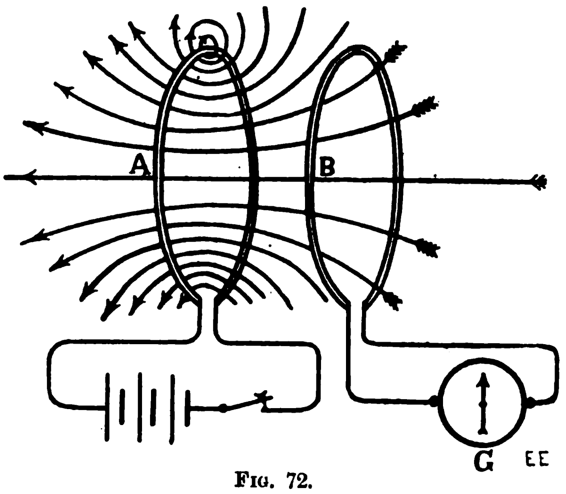

Fig. 72.

Let us suppose that the number of lines through A due to a current i in B is N′. Let the current in each circuit be maintained constant and equal to i, and let the circuit B be gradually moved away from A, until it has travelled so far away from A that practically the whole of the lines through it due to the current in A have disappeared. In moving the circuit B away from A, a certain amount of work will obviously be done, for during its motion the circuit B is cutting lines proceeding from A, and this gives rise to a counter E.M.F. in B, so that work must be spent in maintaining the current against the counter E.M.F.* The circuit B has a current i flowing in it, and in moving it away from A we have caused it to cut N magnetic lines. Hence by Art. 32 the work done in separating the circuits is N i.

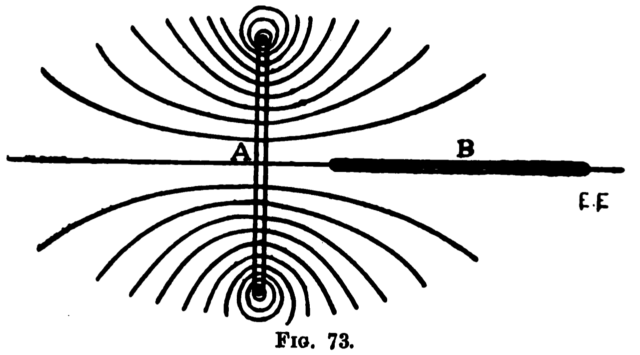

Fig. 73.

Let us next suppose that instead of moving B we keep B fixed, and move A to a very great distance. The work done will in this case be N′ i.

But the work done in moving B away from A must obviously be the same as that done in moving A away from B, since for any given distance between the two circuits the force exerted by A on B must equal that exerted by B on A. Hence we must have

$$N\,i = N'\,i,$$

or

$$N = N',$$

which establishes the proposition stated above.

104. Using this result, we define the *mutual inductance* (or *coefficient of mutual induction*) between two circuits as follows :

The mutual inductance of two circuits is the magnetic flux through one of them due to unit current in the other.

105. We are now in a position to investigate the establishment of a current under a steady impressed E.M.F. in a circuit which, besides having (self) inductance, has also mutual inductance.

Referring to Fig. 74, let us suppose that a steady E.M.F. of amount E is applied to the circuit A, of resistance r_1, and inductance L_1. Let the resistance and inductance of B be r_2 and L_2 respectively, and let the mutual inductance of the two circuits be M. The problem is to find the law of growth of the current in A.

Let i_1 and i_2 stand for the instantaneous values of the currents in the circuits A and B respectively, and let i_1' and i_2' stand for their rates of change (Art. 33). Consider, in the first place, the various E.M.F.'s which we have in the circuit A. These are: (*a*) the $r_1\,i_1$ E.M.F., which is required to maintain the current i_1 through the resistance r_1; (*b*) the $L_1\,i_1'$ E.M.F. required to balance the counter E.M.F. due to the inductance of the circuit; (*c*) the $M\,i_2'$ E.M.F., which is required to balance the induced E.M.F. in A *due to the variation of the current in B*; (*d*) the impressed E.M.F., E. This latter must obviously be equal to the sum of the former three, so that

$$r_1\,i_1 + L_1\,i_1' + M\,i_2' = E \quad . \quad . \quad . \quad (\alpha)$$

Similarly, in the circuit B we have the three E.M.F.'s $r_2\,i_2$, $L_2\,i_2'$, and $M\,i_1'$. Since there is no impressed E.M.F. in B, we have

$$r_2\,i_2 + L_2\,i_2' + M\,i_1' = 0 \quad . \quad . \quad . \quad (\beta)$$

If the values of i_1 and i_2 at any instant are known, then we can calculate the corresponding values of i_1' and i_2' from the above equations. For, multiplying equation (α) by L_2, and equation (β) by M_1 and subtracting the latter from the former, we find

$$i_1' = \frac{L_2\,E + M\,r_2\,i_2 - L_2\,r_1\,i_1}{L_1\,L_2 - M^2}.$$

Substituting this value for i_1' in equation (β), we get

$$i_2' = -\frac{M\,E - M\,r_1\,i_1 + L_1\,r_2\,i_2}{L_1\,L_2 - M^2}.$$

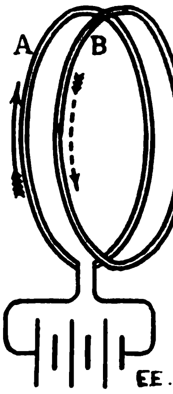

Fig. 74.

106. By using the above equations, and applying a step-by-step process similar to that used in Art. 36, we are able to draw approximately the curves showing the growth of the current i_1 in circuit A, and the growth and decay of the current i_2 in circuit B. We proceed to illustrate the method by a numerical example.

Let an E.M.F. of 100 volts be applied to a circuit of resistance 10 ohms and inductance ·05 henry, another circuit, of resistance equal to five ohms, and inductance 0·4 henry, being placed in the neighbourhood of the first

* If we suppose that the fields due to the two currents oppose each other. But if they have the same direction, then the E.M.F. induced in B during the motion will be an adjuvant E.M.F., and will assist the current, so that work will be given to B and not spent upon it as in the first case.

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circuit and in such a position that the mutual inductance is ·02 henry. Substituting these values in the expressions for i_1' and i_2' obtained above, we get

$$\left.\begin{aligned} i_1' &= 2{,}500 + 62{\cdot}5\, i_2 - 250\, i_1 \\ i_2' &= -\,(1{,}250 - 125\, i_1 + 156{\cdot}25\, i_2) \end{aligned}\right\} \quad . \quad (\gamma)$$

At the commencement, when the time $t = 0$, we have $i_1 = 0$, and $i_2 = 0$, so that the initial rates of current growth in the two circuits are $i_1' = 2{,}500$ and $i_2' = -1{,}250$. We shall assume that these rates of growth remain constant until i_1 reaches, say, $\frac{1}{20}$th of its steady value—*i.e.*, ·5 ampere. Since i_1 grows at the rate of 2,500 amperes per second, the time taken by i_1 to reach a value of ·5 ampere will be $\frac{\cdot 5}{2{,}500} = \cdot 0002$ second. At the same time, the current i_2 has been growing at the rate of $-1{,}250$ amperes per second, and, therefore, the value reached by it at the end of the ·0002 second is $-1{,}250 \times \cdot 0002 = -\cdot 25$ ampere. At the end of that interval, we take into account the fact that the rates of growth of the two currents do not remain constant, and, using the values $i_1 = \cdot 5$ and $i_2 = -\cdot 25$, we calculate from equations (γ) the new rates of growth. We thus get

$$i_1' = 2{,}500 - 62{\cdot}5 \times \cdot 25 - 250 \times \cdot 5 = 2{,}359 \text{ approximately,}$$

and $i_2' = -(1{,}250 - 125 \times \cdot 5 - 156{\cdot}25 \times \cdot 25) = -1{,}148$ approximately.

As before, we suppose that these new rates of growth remain constant until i_1 has again increased by ·5 ampere. This will take $\frac{\cdot 5}{2{,}359} = \cdot 000212$ second approximately. During the same time, i_2 will have increased by $-1{,}148 \times \cdot 000212 = -\cdot 243$ ampere. Corresponding, therefore, to $t = \cdot 0002 + \cdot 000212 = \cdot 000412$ second, we have the values $i_1 = 1$ and $i_2 = \cdot 493$. Substituting these new values of i_1 and i_2 in equations (γ) we once more calculate the corresponding values of i_1' and i_2', etc.

Proceeding in this way, we obtain the following set of values :

$t =$	0	·0002	·000412	·000637	000878	·001135	·001413
$i_1 =$	0	·5	1·0	1·5	2·0	2 5	3·0
$i_2 =$	0	– ·55	– ·493	– ·727	– ·957	– 1·18	– 1·39
$t =$	·001713	·00204	00240	·00280	·00325	·00376	·00435
$i_1 =$	3·5	4·0	4·5	5·0	5 5	6·0	6·5
$i_2 =$	– 1·59	– 1·77	– 1·94	– 2 09	– 2 22	– 2·33	– 2·41
$t =$	·00504	·00588	·00694	·00386	01047	01423	—
$i_1 =$	7 0	7·5	8·0	8·5	9 0	9·5	10
$i_2 =$	– 2·44	– 2·43	– 2 37	– 2·20	– 1·87	– 1·27	—

Using this table, we may plot the curves showing the growth of the current i_1 to its steady value of 10 amperes, and the growth and decay of the current i_2. These curves are shown in Fig. 75. The student will find it instructive to compare Fig. 75 with Fig. 26, Art. 36, which shows the rise of current in the circuit A when there is no mutual inductance. For the sake of convenience, the curve of Fig. 26 is reproduced (dotted) in Fig. 75. The student will at once notice that one of the effects of mutual inductance is to *accelerate the initial growth of the current.* Starting from the origin, the two curves *diverge*, then for a time run almost parallel to each other; after that they begin to *converge*, and ultimately the dotted curve *crosses* the full line one, so that at a certain instant (corresponding to a considerable fraction of the steady value of the current) the current will have the same value, whether mutual inductance be present or absent. Beyond this point the current will grow more rapidly if mutual inductance is absent.

107. The above results might have been predicted from the following purely physical considerations. When an E.M.F. is applied to the circuit A (Fig. 74), then, as soon as a current makes its appearance in the circuit, it induces a current in the circuit B, the direction of this induced current being that of the dotted arrow. The induced current in B reacts on A, and induces in A an *adjuvant* E.M.F., thus accelerating the growth of the current. This goes on so long as the current in B is increasing numerically. A stage, however, is soon reached when the E.M.F. induced in B is too small to maintain the current, and the latter begins to decrease. During the decrease of the current in B an *opposing* E.M.F. is induced in A, which now *retards* the growth of the current. This fully explains the crossing of the two curves, and we see why it is that the growth of the current in a circuit is during its early stages

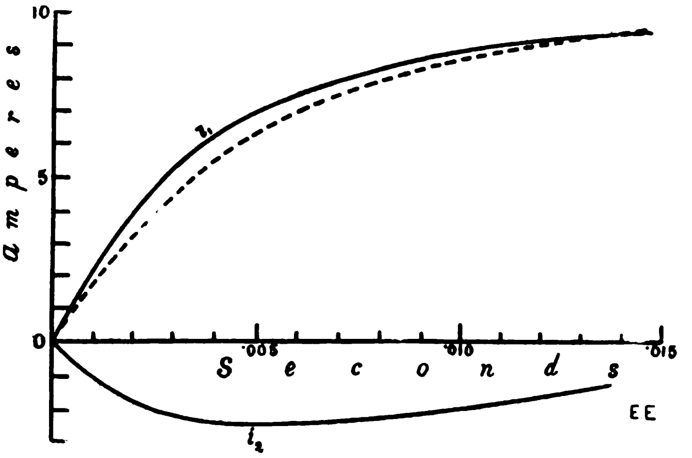

FIG. 75.

accelerated, and during its later stages *retarded*, by the presence of mutual inductance.

(*To be continued.*)

THE STORAGE BATTERY AT THE MANCHESTER CORPORATION ELECTRIC LIGHT WORKS.

A very considerable and valuable addition to the capacity of the Manchester Corporation electric light works has recently been made by means of a storage battery equipment. The battery is installed in the immediate vicinity of Hunt's Bank, at a distance of one mile from the central generating station, and is charged from the ordinary distributing mains of the existing five-wire system. At the battery sub-station a motor generator is employed to give the requisite addition to the ordinary pressure of supply that is necessary to overcome the back E.M.F. of the battery. The motor generator is designed to carry the mormal charging current of 300 amperes, and to raise it from 410 to 590 volts. The battery has been supplied and erected by the Chloride Electrical Storage Syndicate, Limited, Clifton Junction, Manchester, and consists of 224 cells, each containing 73 plates of their well-known "R" type. The containing cells are of stout sheet lead, and are carried on iron and timber stands, and the battery is insulated throughout by means of duplex oil insulators. The plates are supported in the cells by means of glass side plates or hangers, and separated from each other by solid glass rods. The frame of each plate is cast with an extension lug, which is homogeneously burnt with the corresponding lug of opposite polarity of the next cell on to a continuous lead T section, which runs between each cell, supported on porcelain oil insulators. The connection between tier and tier of cells is effected by means of solid copper rods where the same are carried overhead, and by means of vulcanised rubber covered cables encased in lead where carried beneath the floors. The entire battery is subdivided into four distinct batteries, each consisting of 56 cells, and is coupled on to the five-wire network of mains. Each of the batteries so formed is again subdivided into two parts, one part consisting of the battery proper of 44 cells, the other, the regulating portion, consisting of 12 cells. The whole battery is erected in five archways under the main roadway, three of the archways containing the four main portions of subdivided battery, the fourth being employed to contain the four sets of regulating cells, while the fifth is devoted to the motor generator and switchboard arrangements.

In the accompanying views No. 1 shows the type of the

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four main batteries, while No. 2 is a view of the general arrangement of the four sets of regulation cells. Twelve regulating cells are employed with each battery, the connections between which and the switchboard are made by means of solid copper rods carried round the wall on porcelain insulators fixed in iron supports, specially designed for the work by Mr. C. H. Wordingham, the Corporation electrical engineer, to whom is also due the general design and arrangement throughout.

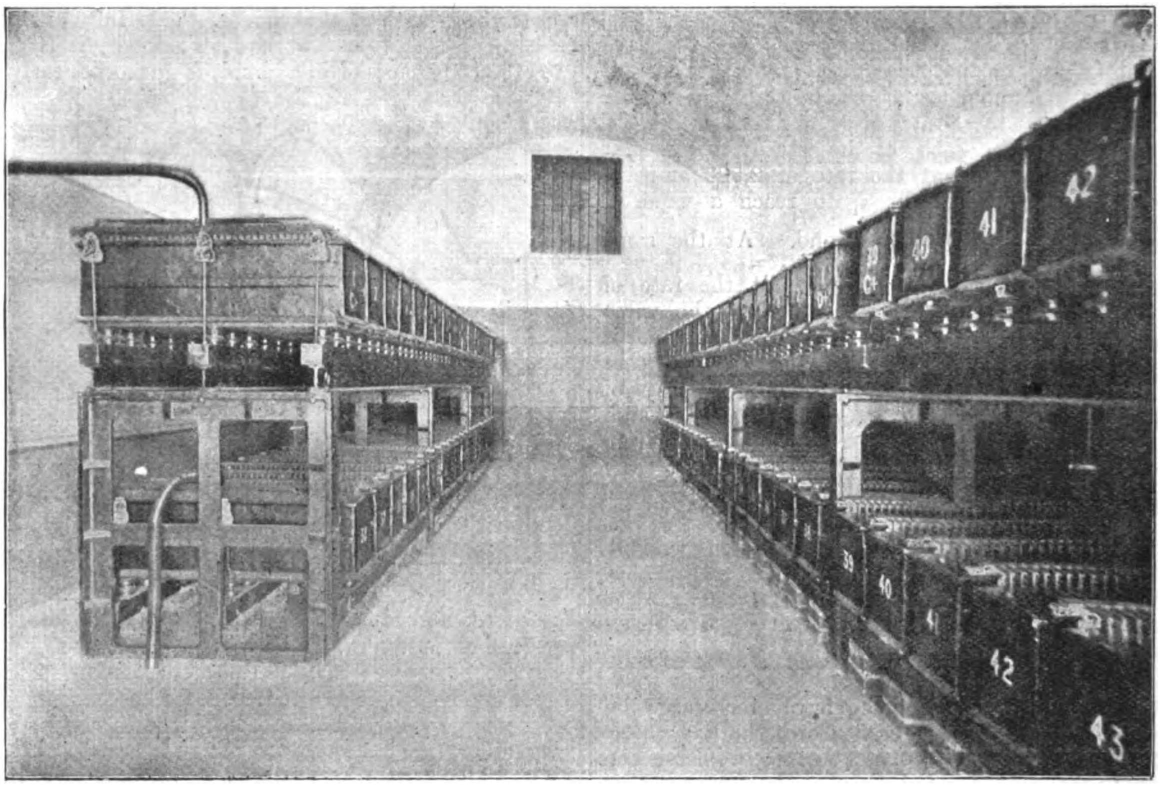

FIG. 1.—Main Battery, C and D.

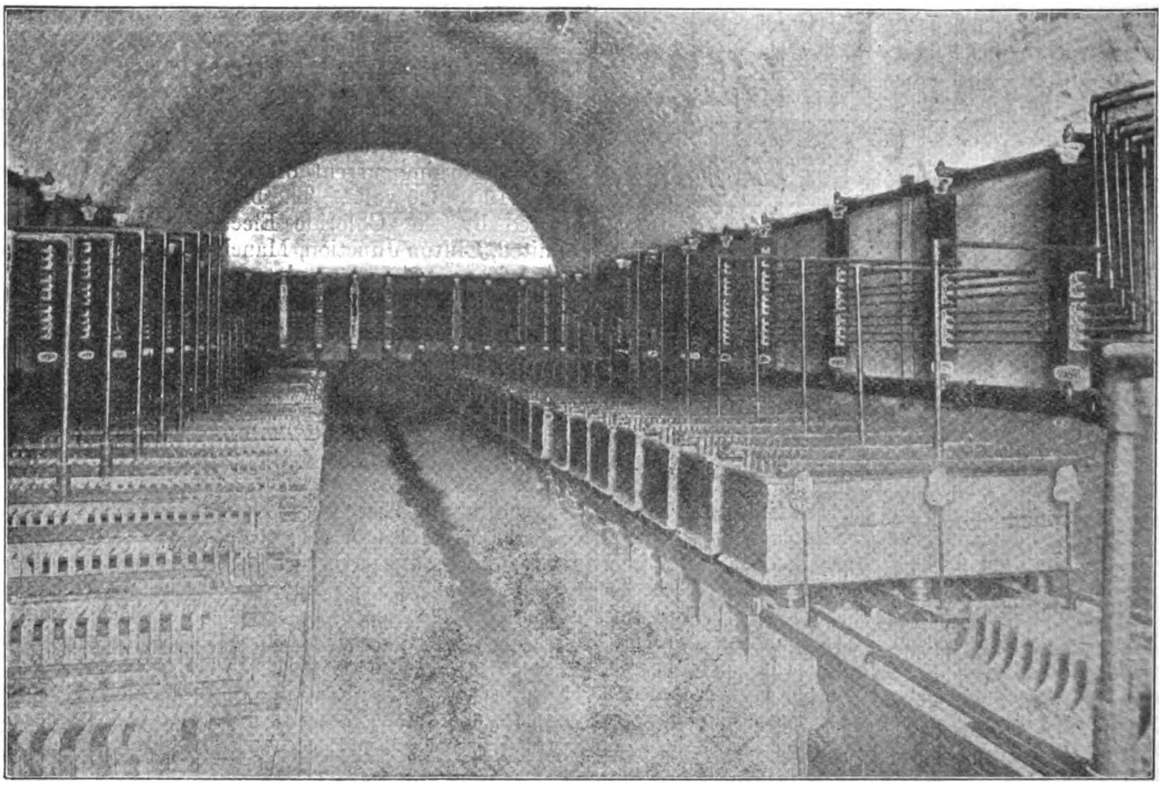

FIG. 2.—Regulation Cells of Batteries, A, B, C, and D.

The electrical details of this battery are as follows: The maximum rate of discharge is 600 amperes from each of the four batteries, or a total of 2,400 amperes at 100 volts delivered in the mains; the normal rate of discharge is 300 amperes from each battery, and under the latter conditions the total watt-hour capacity of the battery reaches one million and a quarter watt-hours. The normal charging current is 300 amperes. The above figures show what a valuable reserve the battery (the largest individual one, we are informed, in the United Kingdom) forms to the central station, and on more than one occasion since the battery was brought into operation at the end of last spring has its value been demonstrated.

The whole night load after midnight of the central station is taken by the battery, and has enabled the third shift of hands—viz., 10 p.m. to 6 a.m.—to be almost entirely dispensed with, while on Sundays relief is also given to the second shift, the battery taking the day load up to 4 p.m., in addition to the previous night load.

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THE ELECTRIC LIGHTING OF THE GUARDIAN INSURANCE COMPANY'S OFFICES.

The new buildings of the Guardian Insurance Company are a splendid example of modern architecture, and every detail in their construction shows careful forethought. The walls throughout the entire building are either covered with marble slabs or tiled, and the whole of the floors are fireproof. The electric lighting of buildings so decorated is no easy matter, as alterations cannot be made after completion. The work in this instance has been carried out under the able direction of Messrs. Handcock and Dykes, consulting engineers, of 5, Victoria-street, to whom we are indebted for the following particulars. The system adopted throughout the building is that of drawing well-insulated wires into iron pipes buried behind the tiles or marble facings. The chief feature in the system is, however, the arrangement of these pipes so that the wires can at any time be withdrawn and replaced should the necessity arise. The supply for some 350 lamps is taken from the mains of the City of London Electric Lighting Company. This number of lights necessitated the connection to the three-wire distribution network, and three-wire circuits are run throughout the building. In this way balance is obtained in each department, and no large room is connected to only one side of the system. The company's mains enter in the basement and terminate in a fuse-box. The engineers have provided near this place a three-pole switch of the Edison-Swan type, and three fuses. These fuses are of such section that should a short-circuit occur they would go before the company's fuse, and hence the supply would not be wholly cut off. They and the switch are contained in an iron box, with glass front, which will be kept locked, but the plate-glass front can be broken in an emergency should the attendant be away. From this point the two outside wires are led through an iron pipe to the main circuit-board. The central wire is, however, branched off at the lift. There are eight circuits on each outside wire on this circuit distributing board, one circuit on each side going to the same department. The fuses are covered with handsome embossed bronze cases lined with asbestos, which are held in place by thumb-screws. The circuits for the whole of the office lights are controlled from this board, but the lights on the staircases and in the caretaker's room are on a separate circuit-board on the top floor. In this way the whole of the circuit switches can be turned off at a fixed time each night to prevent an odd lamp being left burning. From this main board the circuit wires go back to the lift, where they ascend in a 3½in. pipe. The mains to each floor or department, as the case may be, are taken to fuse-boards, also of the Ediswan type, and there split up into small circuits, each carrying six lamps as a maximum. On these boards fuses are inserted in both wires, and no individual fuses are used anywhere in the building.

The iron pipe system is continuous throughout, the pipes being uninsulated, but treated with Angus Smith's composition. Draw-boxes are placed at every acute angle and over every ceiling light. These boxes are generally circular in form, and are of cast iron. The pipes are screwed into them, and the covers are simply dropped in. These covers are in all prominent positions, fitted with either inlaid mosaics or wood to match the floors. As will be gathered from the above, few joints are required in the insulated wires leaving the fuse-boards. The joints necessary are all vulcanised, and with this and the use of the best classes of wire, an insulation resistance considerably higher than that required by the company has been obtained. This is an exceedingly good result when considered with the fact that the iron pipes are earthed. The pipes were all put in first, and after the walls and floors had been finished the wires were drawn in. This complete system was first devised by the engineers for the Commercial Union Assurance Company's building, which was finished in May last.

Fittings.—The fittings used throughout this building are of a most substantial type, and several of the designs are entirely new. The desk standard (Fig. 1) was designed by the engineers specially for office lighting. The opal shade, together with the ground-glass disc under it, completely cover the lamp, so that the naked filament can never be seen. The result is a good dispersed light without the large contrasts which are bad for the eyesight. When the lamp has to be replaced, the brass ring supporting the shade is lowered by slacking off the screwnut

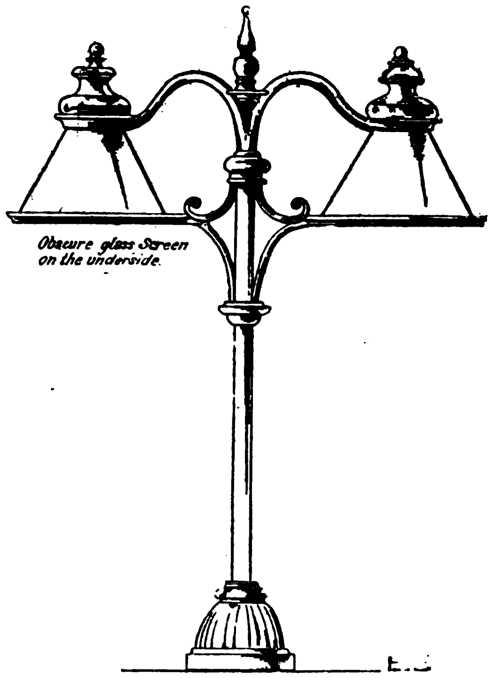

FIG. 1.—Two-Light Desk Fitting, with Opal Shade and Ground-Glass Screen.

on the column. The cone shade then is held up while the ring and ground-glass plate are turned round through 180deg. The lamp is then accessible, and the opal shade also comes away. These fittings are substantially cast in brass, the exteriors being bronzed. Two switches of the tumbler type in the base control the lamps. Single fittings of a similar type are used on some desks, and in every case the iron pipes are screwed to the base of the fittings. The switches on the walls controlling ceiling lights, as in Figs. 2 to 5, are also sunk in. The plates covering them and holding the tumblers are of embossed bronze work of special design. These go very well with tiled walls, being neat and unobtrusive. The switches throughout the corridors and in the various rooms are always arranged so that you can light up the space in front

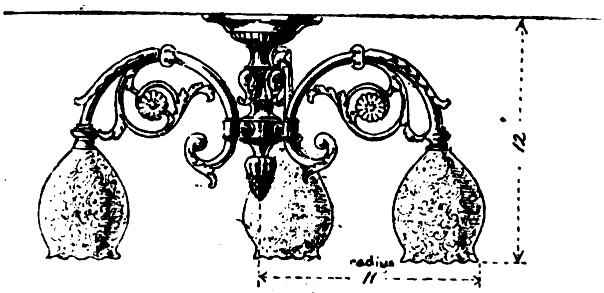

FIG. 2.—Bronze Fitting for Three Lights used in General Office.

before entering. All the fittings are bronzed—the better ones being supplied by Messrs. Perry and Co., of Grafton-street. The type of fitting used in the main offices to light from the ceiling is shown in Fig. 2, but the globe finally selected hardly surrounds the lamp quite as much as shown in the illustration.

Fig. 3 is of another type used in several places. In the Board-room this design is employed with five arms instead of three. Brackets to match (Fig. 4) are placed on the walls of this room. The single-light fitting (Fig. 5) is of the type most usually found in the waiting-rooms and in a few of the corridors. In the great majority of cases 8-c.p. lamps have been found sufficient. This is doubtless owing to the reflecting power of the tiled walls. In the basement and general lavatories, where a light is always required, a few 2½-c.p. lamps have been fixed, and

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give quite sufficient light for all ordinary purposes. In the strong-room, portable hand lamps, similar to those used on board ship, are provided for convenience when searching amongst the stored records. In the basement, the iron pipes containing the conductors

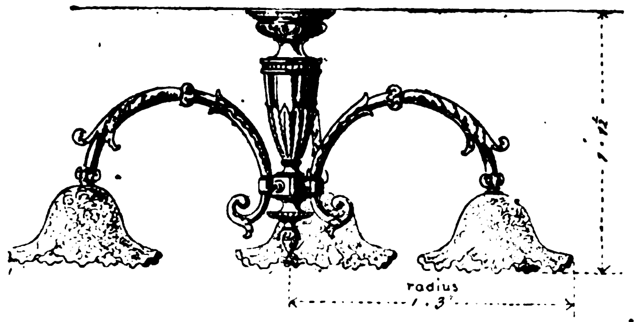

FIG. 3.—Type of Ceiling Fitting used in Board-room.

are secured to the surface of the walls. The staircase lighting is controlled by two switches—one at the bottom and one in the caretaker's quarters—so that the whole of the lamps can be turned on or off from either place. The contractors for the work are Messrs. Hayward Tyler and Co. The surveyor of the Guardian

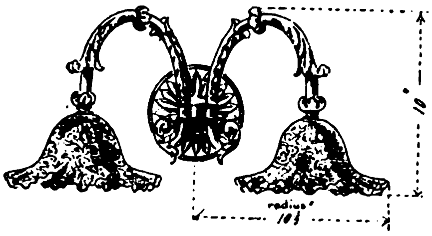

FIG. 4.—Two-Light Wall Bracket.

Company (Mr. Human) has taken a very active interest in the carrying out of the installation, being determined that no fault whatever should be found with the electric lighting of the head offices of the company. The

FIG. 5.—Single Light Fitting.

result of the efforts of all concerned are most pleasing, and we have no doubt but that the architect of the building, Mr. J. Macvicar Anderson, past-president, R.I.B.A., will endorse our opinion that the electric light contributes largely to the good effects of the architecture.

A NEW SYSTEM OF SERIES ARC LIGHTING.*

BY THOMAS SPENCER.

Anyone who has watched the development of arc lighting within recent years cannot have failed to notice the gradual, but radical, changes that have taken place in the methods of delivering light from a central station. Originally the idea seems to have been to break up the source of current supply into a great number of small units. Whether, from an engineering standpoint, this idea was a well-worked-out scheme, or simply the outgrowth of circumstances, is, I think, very easy to answer; for it is usual to begin on as small a scale as possible, so that, in case of failure, the financial loss will be as small as possible. These first attempts proving successful, the conservative feeling, which to a great extent accompanies the investment of money, caused a continuance in the course which had been found practical.

* A paper read before the Franklin Institute, September 22, 1896, and printed in the *Journal* of the institute for October.

Perhaps in no branch of the electrical industry is this so apparent as in that of arc lighting. However, at present there seems to be a general tendency towards a more economical system, as is attested by the number of large arc light dynamos that are now replacing the numerous small machines; further, by the rapid rise of arc lighting from constant-potential D.C. circuits, and also by the general interest manifested in alternating arc lighting. The last named, which, of course, signifies the use of constant potential, is the direction towards which everything seems to be tending, and will be the system most generally employed in the future, unless some efficient method of directly converting heat into electricity is discovered.

There is no question but that a station equipped with large units and supplying one kind of current—and that a current which can most easily be controlled—is the most efficient. Such is the alternating current. As far as the alternating arc lamp is concerned, it has some points which make it slightly inferior to the direct-current lamp; but experience has shown that these objections are not so serious as at first appeared.

Recently, attempts have been made to use a device by means of which the current is commutated into a fluctuating current, having always one direction, but not with conspicuous success. There are several such plants in England, I believe, and, from some of the criticisms, I should judge that the system is by no means as efficient as it should be to be generally introduced, especially in this country, where, I am sorry to say, a piece of apparatus is apt to fall into the hands of men who fail to give it even the most necessary care. As for the advantages gained by the use of such a device, there is no doubt but that the efficiency of the arc is improved. From my experience I

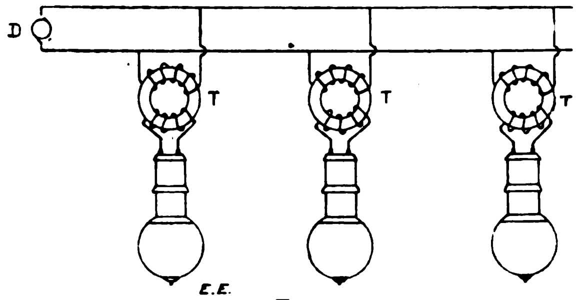

FIG. 1.

should judge that, as the current is a fluctuating one, the arc would still be noisy, although less so than the unrectified alternating current.

As I have said before, the objections to the alternating arc have not proved to be as serious as they at first appeared. There is a growing tendency towards the use of the alternating arc for all kinds of lighting, and this is especially marked in street-lighting. The system which up to the present time has been in use may be described as follows: Each lamp is burned separately from a 30 or 33-volt transformer (see Fig. 1). The amount of wire used in this system is not generally greater, and often less, than that required in the old direct-current series system. This system works very well and has many good features, perhaps the greatest of which are that each lamp is independent of the rest, and that the pressure on the lamp is low. Furthermore, the lamp has only one series spool of coarse wire, and is free from shunt spools and cut-outs.

There are a great many systems of this sort operating in this country, and some, I believe, have been introduced in England. The only objection to this plan is its high first cost, occasioned by the necessity of a separate transformer with each lamp. To overcome this objection and at the same time be in position to use the same kind of lamp, Mr. William Smith Horry has devised what he calls his "reactive system" of arc lighting, which I wish to bring before you this evening. Mr. Horry couples his lamps in series directly in the primary circuit, doing away with the separate transformers. Now anyone who has attempted to run arc lamps in series, which regulate only by variations in current—that is, have only a series spool—knows very well that they will not operate. The reason for this is readily

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apparent. An arc lamp should depend for its regulation on something practically affected only by the burning of its own arc. This is evidently not the case with the current where lamps are put in series across a constant-potential circuit. In general, when lamps are run in series, we must regulate by the change of E.M.F. around the arc—that is, regulate with a shunt spool. A lamp, of course, similar to the regular series arc lamp might be used if it were provided with some device to keep the current constant, or a lamp similar to that used on street railway circuits could be devised, but in all of these cases we would have a much more complicated lamp than that used by Mr. Horry.

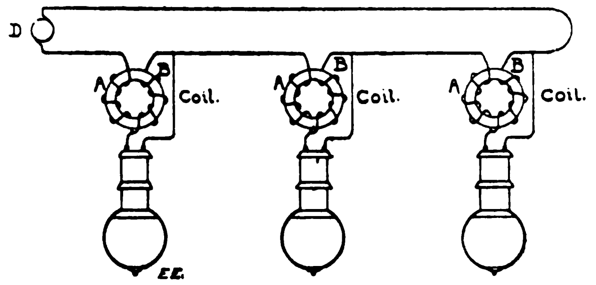

Fig. 2.

The principle governing Mr. Horry's system is briefly this: In shunt with each lamp is placed a small coil of the type known as auto-transformer (Fig. 2). The coil, A, is in series with the lamp, and B in shunt. With this device the current in the lamp will always be greater than that in the line. Considering the current in the line as constant, which is practically the case where a large number of lamps are in series, we must, as shown above, by some means outside of the lamp itself, cause a change in the current passing through the series spool of the lamp in order to enable the lamp to feed. This is accomplished by making the amount of iron in the coil small, so that it will soon become saturated and cause the coil to leak, lowering the pressure, which in turn decreases the current and feeds the lamp. This can be more easily understood in the following way. The relation

$$N_1^2 I_1^2 = N_2^2 \; I_2^2 + \left(\frac{l B}{4 \pi \mu a}\right)^2$$

in a transformer, where there is no leakage between the primary and secondary, is well known. (Fleming, "Alternating-Current Tranformer", vol. i., p. 273.) Here N_1 and I_1 are respectively the number of primary turns and the maximum current, and N_2 and I_2 represent the same for the secondary, B the maximum induction, μ the equivalent permeability, l the length of the magnetic circuit, and a its section.

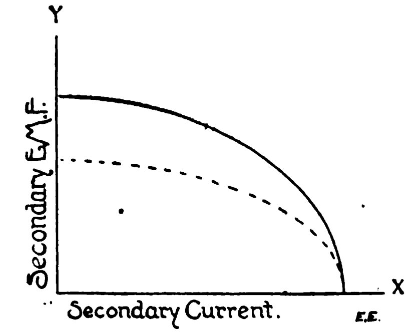

Fig 3.

Now, the secondary E.M.F. is directly proportional to B, or $B = K y$, where y is the secondary E.M.F. and K a constant. If in the first equation we write x for I_2, and substitute the value of B, we have

$$N_1^2 \, I_1^2 = N_2^2 \, x^2 + \left(\frac{l K y}{4 \pi \mu a}\right)^2,$$

$$\therefore 1 = \frac{x^2}{\left(\frac{N_1 I_1}{N_2}\right)^2} + \frac{y^2}{\left(\frac{4 \pi N_1 I_1}{K} \times \frac{\mu a}{l}\right)^2}$$

Now, if we suppose I_1 constant, and write

$$a = \frac{N_1 \, I_1}{N_2},$$

and

$$b = \frac{4 \pi N_1 \, I_1}{K}.$$

a and b being constants, we have

$$1 = \frac{x^2}{a^2} + \frac{y^2}{\left(b \times \frac{\mu a}{l}\right)^2}$$

This is easily recognised as the equation of an ellipse. Plotting this (Fig. 3), it is plain that when the current is small the E.M.F. varies very little with an increase of current—that is, it behaves in this region as a constant-potential circuit. Referring again to our last equation, we see that when

$$\frac{l}{\mu s}$$

becomes greater—that is, when the equivalent magnetic resistance becomes greater—the minor axis of the ellipse becomes smaller. This is accomplished, as before stated, by diminishing the amount of iron in the core of the coil, and, as a result, we will have a coil whose characteristic is an ellipse, as represented by the dotted lines. In this case the maximum E.M.F. will not be so large; but as the ellipse is nearly flat, there is a large region over which the coil produces practically constant potential.

There are few other features in this system worthy of mention. The coil is so proportioned that when the carbons are consumed, and the arc in consequence breaks, the whole current is forced through that portion in shunt with the lamp. The choking effect in the coil is about the same as the E.M.F. taken by the lamp when burning; in fact, it is so close to this that 30 per cent. of all the lamps in circuit may be put out without sensibly affecting the ampere-meter in the circuit. The coil then not only acts as a cut-out, but also as a regulator.

The advantage which this system shares with that in which lamps are run from separate transformers is that it is possible to run lamps of widely different candle-power on the same circuit, which is accomplished by changing the coil to conform with the lamp. In this particular, of course, it is an improvement over the ordinary series system, with shunt-coil regulation. The number of lamps which it is possible to run in series from a 1,000-volt circuit or transformer depends upon the candle-power of the lamps. The coils, as now constructed, will, in this case, take care of 29 2,000-c.p. lamps. Mr. Horry has also devised a switchboard to be worked in connection with a special transformer in such a way as to give varying primary E.M.F.'s, so that any number of lamps can be run in series within reasonable limits.

As for the practical working of this system, I would say that it is in use in several places in this country. As far as I know, it has been very satisfactory, and there is little doubt that a great future awaits it.

INSTITUTION OF ELECTRICAL ENGINEERS, Nov. 26.

At last night's meeting of the Institution the following candidates were balloted for:

Associates.—George Adams, 55, Victoria-street, Westminster, S.W.; Thomas W. Allan, 9, Smith-street, Kennington Park, S.W.; Robert W. H. M. Bland, "Fernagh," Whiteabbey, Belfast; Harold Vincent Bowen, 41, St. Mark's-road, Wolverhampton; Ivon Braby, Bushey Lodge, Teddington; Arthur F. Evans, P.O. Box 2153, Johannesburg; Thomas Bennett Groves, care of Messrs. F. and C. Osler, Old Court House-street, Calcutta; Herbert Hampton Hall, 20, Errol-street, Aigburth-road, Liverpool; William Harling, "Vine Grove," Eccles Old road, Pendleton; Herbert T. Marks, P.O. Box 1941, Johannesburg; William Edward Moore, Johannesburg; Charles Steers Peel, 4, Mansion House-buildings, London, E.C.; George Stobie, Durban, Natal; Andrew Sweet, 102, Hampstead-road, N.W.; Albert Edward Williamson, "Clevelands," Epsom-road, Guildford; James Cowan Woodburn, 2, Hughenden-terrace, Kelvinside, Glasgow; George Herbert Wyatt, Moouta, South Australia.

Students.—Alick James Newport Kenneth, 14, Hulme-street, Salford; Martin Amyas Shepstone, P.O. Box 1180, Johannesburg; Frank King Westbrook, 32, Abbey-road, St. John's Wood, N.W.

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BRITISH BRAINS.

It is not often that "stupidity" writ large is admitted into the columns of the *Standard*, but for the singularity of argument a letter in its columns the other day takes the cake. Here is the letter:

"Sir,—The following fact may act as a warning to those who look at foreign progress in commerce as due to causes beyond the control of British brains. In a large Continental city tenders were lately invited for an electric plant. Agents, both English and foreign, tendered personally, and a German firm obtained the contract. One English house tendered, through its agent, with weights and measures calculated in pounds and yards, and when the agent was requested to turn his figures into decimal weights and measures he could not do so, and his tender could not even be considered. How long is British trade to be thus handicapped, not by the want of compulsory metric legislation, but by crass obstinacy (the word ignorance is out of the question in these days of Board schools, of course), which will not adapt itself to the requirements of the world's trade."

We think the crux of the letter is to be found in the words "he could not do it"; in other words, in his incapacity. To found an argument for the compulsory adoption of a system which, to say the least of it, has opponents whose knowledge is great and experience world wide, upon so slight a foundation, savours of recklessness. We who agree with the opponents of the metric system admit our "crass obstinacy" on the subject, whatever that may mean, and our objections will not be removed by the inability of this or that agent to do simple arithmetical calculations. Why did not the agent go to the nearest school and get a schoolboy or girl to work his little sums for him—that would have shown wisdom; but the above letter, probably written in great haste and without thought, does not show much wisdom. The exponents of the metric and decimal systems have run their hobby to a great length—so far, indeed, that a reaction has begun to set in. One point, however, which may appeal even to the pachyderms metrical is involved in the question whether the trade involving "pounds and yards" is less or greater than is involved in a trade under other systems of weights and measures. We have reason to believe the answer must be "greater." If so, the major is asked to give place to the minor. It seems incredible, however, that any agent selected to represent an English firm should be unable to reduce one set of weights and measures to another set of weights and measures.

TRADE ENTERPRISE.

The old method of gaining business by the personal recommendation of previous customers is without doubt a good method, but is rather too slow for the present times. Manufacturers of specialities wish to extend their connection more rapidly than can be done in this way. The generally accepted substitute is that of advertising, but we have lately come across other new ideas worthy of note, if only for their presumption. In two cases the articles pushed were special types of dynamo brushes, and we grieve to say that the inventors of the systems were German firms. The first maker forwards a sample brush of ventilating type, and claims great advantages for it. His prices are high, but whether the increased price is warranted by longer wear could only be ascertained after a lengthy trial. The gentleman concludes his

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circular letter with the following postscript: "I shall feel greatly obliged if, when sending your trial order, you will give me the names of those firms which are known to you as being possessors of dynamos or motors, it being essential for me to enlarge my clientage in consequence of the extraordinarily trifling wear of my brushes." In other words, this enterprising gentleman will be pleased to use the name of his correspondent as a recommendation to other firms. In the other case a firm pushed a particular make of brush, but was willing to supply any other type. It asked the consumer to forward a sample of any type he preferred, so that a quotation might be given. A cheaper way of gaining knowledge of the English makes of brushes could hardly be devised.

CENTRAL-STATION TROUBLES.

There is a good deal of truth in the contention that more may often be learned from failures than from successes. In central-station work there are two sets of causes leading to failures—one set consisting of errors of design or workmanship, the other arising from causes which no ordinary person could foresee or guard against. It serves no good purpose in washing the dirty linen of bad design or workmanship in public, but it is extremely useful that every trouble from unforeseen causes should be published, so that those in charge may gradually tabulate all causes likely to give trouble. Take the case which gave Mr. Fincham, the electrical engineer at Carlow, a bad hour. He had been running satisfactorily for some three and a half hours when suddenly a short-circuit occurred, putting Carlow and Milford into darkness for an hour. The cause was ultimately found to be due to a mouse which had committed suicide by short-circuiting the terminals of the alternator mains. It was found with nose and tail burnt off, and body between the terminals. Possibly engineers of experience, in running over the causes likely to lead to a breakdown, might have thought of this; but we doubt it, and therefore record it. Rats and mice are troublesome customers, and it is difficult to guard against them; but when a failure occurs, the possibility that it may be due to their action must not be forgotten.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

MOTORCARS.

SIR,—Now that the Local Government Board regulations are out, and my assistance is no longer needed in connection with this matter, I have the time to make a few remarks with suggestions to the letters which appeared in a journal of October 31 last.

The British Motor Syndicate appear to accept the proposal I held out in a letter published in your previous issue of October 27. Nothing appears from the Great Horseless Carriage Company, and it would almost seem as if this company had fallen to the background, leaving the British Motor Syndicate to stand alone. A few lines of explanation to you might clear up the point. The British Motor Syndicate only meets my suggestions halfway, and to make the matter clearer I take this opportunity of stating my position in regard to the self-propelled traffic question, because my course of action has been misrepresented by many, judging by the newspaper cuttings which have come to hand.

I have always taken a keen interest in motor traffic, and so far back as the seventies I had two electric tricycles running, which were constructed here.

I was fortunate enough to obtain all the concessions asked for in personal interviews at headquarters. They were chiefly these: (1) definition of all unladen vehicles; (2) steam and smoke permitted due to temporary causes or accident; (3) the placing of light locomotives on even ground with horse traffic; (4) leaving question of construction and regulation to the Local Government Board; (5) taking all powers from the local authorities; (6) a drawn vehicle to be permitted. It will be admitted that the points mentioned are the making of the Act, and it was no easy matter to convince the Local Government Board on all points.

Then came the regulations. Here I did my best to render all assistance in my power, and gave up all the necessary time for the purpose. In order to clear up the petroleum question, I framed my evidence before the Parliamentary Committee in such a way as to indicate the safe lines on which to frame the regulations, and these have followed the course indicated—no small compliment to myself. In short, up to the date of the Act coming into force, my energies have been devoted to pushing the question to a successful issue, and keeping the public informed on the progress of the movement, also warning them not to invest money in motor carriage companies without circumspection. It would appear that, having dealt with the latter point, I am anxious to drive to the wall the new companies formed on principles which I regard unfair from a public point of view. This is not the fact. If these companies are prepared to sell their goods at fair values, and permit purchasers to import at a reasonable royalty, then I have little to say in regard to the companies as such. Indeed, in the interests of the shareholders, the patents purchased by these companies had best be kept out of the law courts, and fair profits are the only means to bring about such a result.

It might be enquired why I speak in this fashion concerning the new companies. I have received a vast number of applications for information regarding motor carriages, many being practically firm orders. Whenever special types were enquired for which I believed were held by the new companies, the writers were referred to those quarters, though with great hesitation, not being assured that the treatment would be fair after what I read on one of the prospectuses in regard to profits. If I am reassured on this matter, I shall know how to act in the future. My proposal is: fair prices, free permission to import, leaving the foreign manufacturer to pay 10 per cent. royalty for importation on the price actually paid by purchasers—*i.e.*, after discount, say, not exceeding 10 per cent. on the manufacturer's published price list. This would not hamper an ignorant purchaser who is unable or forgetful to examine patent right questions. If these points are agreed to, I am ready to refer enquirers and advise friends without feeling that an injury is being inflicted. Some have asked for petroleum-driven motors, others for steam, and I should refer them to suitable quarters to make their enquiries if satisfied in the manner mentioned.

Turning for a moment to the Motor Car Club: this club has for its president Mr. H. Lawson, a well-known company promoter, who must have spread desolation in his path, if his history given in the *New Saturday* of November 7 last is true. It is only natural that I could not follow such a man and join the club. It is to be regretted that the club should be left in financial hands, since it is unfair on many, if not most, of its members. The majority of the officers of the club are also connected with financial matters and company promotion. In my opinion the two should be kept quite distinct, in fairness to the new industry as well as to those who join the club, no doubt in ignorance of the facts mentioned. Much of the unpleasantness of the past would have been avoided had this been done, and many of the difficulties of the future can be removed.—

Yours, etc., DAVID SALOMONS.

Broomhill, Tunbridge Wells, November 20, 1896.

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REVIEWS.

Alternating Currents and Alternate-Current Machinery. By D. C. Jackson and J. P. Jackson. The Macmillan Company. 14s. 6d. net.

This book is the second volume of the text-book on electromagnetism and the construction of dynamos. The matter was got together for a series of lectures, and contains most liberal extracts from the historical literature of the subject. The authors, however, claim to omit references to experiments which are of historical interest only. From the preface we learn "that a few additions have been made to the nomenclature. The most important of this is the introduction of the term 'active' to represent the component of pressure of E.M.F. in phase with current and to represent the working component of current." The authors think that "the introduction of this term removes the inconvenience of which Prof. S. P. Thompson bitterly complains caused by the use of the term 'effective' in the formally adopted meaning of $\sqrt{\text{mean}^2}$." We consider that the addition has complicated matters, and is most likely to confuse a student. Thus he has to grasp a conception that the effective current must be multiplied by the cosine of the angle of lag to be active. Also, the effective E.M.F. must be multiplied by the same cosine to give an active value. Yet the product of these two active values does not give power. Following the subject up, when a condenser is connected to an alternate E.M.F. practically no active values occur. Thus we consider the term "active" most misleading, and also do not see the need for an expression to indicate $\sqrt{\text{mean}^2} \times \cos\theta$— a quantity which is not measured independently. In all practical cases the effective E.M.F., the effective current, and the cosine of the angle of lag are required to be known separately. The first two chapters are devoted to the form of the pressure curves of alternators, and to a general classification of the different types of these machines. The types illustrated, diagrammatically or otherwise, are nearly all English designs now obsolete. In the third chapter self-induction and capacity are defined, and some of the phenomena connected are explained. It is herein that the authors discuss the term "active," and the following is their explanation: "The pressure which is effective in producing current may be called the active pressure, to distinguish it from the pressure which is impressed upon the circuit." The examples of the values of the self induction of various instruments in regular use will be helpful to the student, as giving some idea of what to look for in practice. The hints on the measurements of both self-induction and capacity are also taken from English sources. A chapter on diagrams for solving problems in alternate current working in circuits containing self-induction and capacity, or both, follows, and a few analytical methods are added. The information given under the heading of "The Magnetic Circuit of Alternators" is of use, and will repay careful reading. A due appreciation of what is to be expected from the alternator helps the student materially when learning the elements of design. The authors first lay down on general lines the limits to be observed in such matters as hysteresis loss, induction, ventilation, cooling surface, current density, magnetic leakage, etc., and then run through a typical design. It is a pity, however, that they do not give scale sketches of the design worked out to aid the student in following the dimensions. The rough approximate calculations of the self-induction are useful, but here no guides as to the value to be aimed at are given. As regards the Foucault currents in the cores, the authors point out that whereas the number of complete cycles in a direct-current dynamo is usually about 25, this number is largely exceeded in alternators. Hence more care must be taken to insulate the iron, and thinner iron should be used. The subject of excitation brings up the old question of using rectified currents for providing all or part of the energy for excitation. We are assured that the three largest firms in America are using such devices, but the well-known Ganz rectifier is the only one described. Chapter VI. deals with the characteristic regulation and curves. The authors have adopted the name "loss line" to represent a curve showing the drop in terminal pressure as the alternator load is varied. This is rather apt to be confused with a line representing the losses, which, of course, is a very different thing.

The parallel working of alternators is treated purely from the electrical side, although one is casually informed that an engine running with an irregular angular velocity does not assist matters. Hence the conclusions arrived at cannot be accepted without question, especially when the evidence on which the conclusion is based is gathered from conflicting sources. Thus the authors state that smooth parallel working requires that the armature impedance be reduced to a minimum. Practical experience in this country shows that the too rigid control of alternators with little impedance is most harmful. After an account of the various methods of testing alternators, we come to the chapters on transformers, which are commenced by an investigation of mutual induction. The data of different tests of transformers are convenient for reference, but the reader must always look to the date at which such tests are made. Thus Dr. Fleming's historical test of English transformers is given, although all the transformers in it are now obsolete. The rest of the volume is taken up with "power measurements in polyphase circuits," alternating-current motors, and polyphase transformers. The treatment of the motor question is not full, and yet the standard abstracts will be of great service to the student. The volume is well illustrated, and the collection of abstracts forming the bulk of the matter is valuable. We feel proud that the authors have taken the bulk of these abstracts from English sources.

The Metric System of Weights and Measures compared with the Imperial System. By Prof. W. H. Wagstaff, M.A. Whittaker and Co..

When a man has a hobby and is permitted to preach that hobby, then all his arguments tend in favour of that hobby. Evidently, Prof. Wagstaff is a sincere believer in the metric system. In his eyes it is perfect. To him Mr. Howard's example of our own system is a bit of finesse. Its solution is easy because of certain coincidences. He does not seem to realise that with the metric system he selects those examples which seem most to favour his argument. Thus, Mr. Howard does not stand alone in putting forward something simple on his side to give point to his contention. We candidly admit that we have never yet seen the all-absorbing beauty of the metric system. We agree with Mr. Howard that men find it easier to understand to think in fractions than in decimals of three, four or six places. Further, we have never yet found a suitable argument to convince us that inexact decimals are better than exact fractions. Those who talk about decimals and metric systems always contrive to imagine that practically men have nothing to do with thirds, sevenths, and so on, but always with halves and quarters. Usually, we find ordinary calculations, when made by men who have a good knowledge of arithmetic and may be, for all one knows, unacquainted with higher mathematics, are made in the simplest way—if that happens to be by vulgar fractions, then by that way; if it happens by decimals, then that way. The fact is, that in many instances a decimal system is simpler and more advantageous; but to argue from this that it must be universally simpler is nonsense. Our own system is full of anomalies. True, but it is possible to get rid of anomalies without a drastic change. The author, on pp. 35-6-7, gives a list of anomalies obtained from Mr. Kyle, not one of which has anything to do with our *system* of weights and measures It seems to us perfectly absurd to base an argument for the abolition of the "pound weight" upon a market custom which calls 16lb. of apples a peck and 9lb. of broad beans a peck. If Cornwall says we have a custom to call 224lb. of potatoes a bushel, and Nottingham says we have a custom to call 84lb. of potatoes a bushel, this may be an anomalous proceeding, but it has nothing to do with the abolition of the bushel or the pound. Uniformity may be excellent, but uniformity can be obtained without inflicting upon us the evils of changes of the system of weights and measures. When we saw the title of this book we certainly hoped for something of a totally different character. The whole is merely a summary of the argu-

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ments used before the Select Committee by deputations and by various writers in favour of the metric system. As such a summary the work is a good one, but we trust the arguments in favour of the metric system will not prevail. Better attempt, in the first place, to get rid of some of the anomalous customs, which, we say, have really nothing to do with systems of weights and measures, but which really do exist, and to men not in a particular line of business appear as astounding survivals of "bad customs."

Manual of Electrical Undertakings. Compiled under the direction of EMILE GARCKE, M.I E.E , F.I.S First year. London: P. S. King and Co.

This book will be found very useful to many people connected with electrical companies. It contains a compendious account of the companies connected with telegraphy, telephony, electricity supply, electric traction, electrical manufacturing, some that cannot be classified under these heads, added to which is information relating to provisional orders, companies registered, officials of companies, etc. The introduction consists of a brief historical *résumé* of the various branches of the electrical industry. We feel little interest in either telegraph or telephone companies, but the reader will find the statistics as complete for these sections as is the case with what we may term the engineering section of the work. Probably many people will be surprised to read in the introduction that the capital subscribed for traction work is greater than that subscribed for "electricity supply"—that is, for lighting work—but they must not forget such enterprises as Central London, City and South London, Liverpool Overhead, South Staffordshire, Waterloo and City, etc., come under the head of traction, and some of these are expensive if not extensive works. The information generally given about a company is somewhat as follows: capital, powers, system, directors and officers, accounts at end of 1895, last dividend, previous dividends, and some of the details of the year's work. It will be seen that the information given is of a character constantly referred to. We quite understand the troublesome nature of getting, arranging, and correcting such a mass of statistics, and the impossibility of perfecting a book of this kind with its first issues. The editor and publisher also see this and deprecate harsh criticism. They need not have feared this, for any unbiassed examination will certainly prove that every effort has been made to ensure completeness and accuracy, and the object aimed at has been achieved within reasonable limits. We could wish that in any future issue the list of companies registered was made to show for each such company, not only the nominal capital and number of shares, but the capital subscribed, and in case of dead companies the subscribed capital that was lost. In the boom of 1882 no less than £23,228,000 was the sum of the capital of the companies registered. We know that only a part of this was subscribed, and the greater part subscribed was lost. Again, in the case of municipalities, the time during which the loan runs might be stated, as this is often of some importance. However, if we are not careful we shall give an impression of this book that would be incorrect. It is distinctly good, and so far as we have ascertained accurate, and decidedly wanted.

THE INSTITUTION DINNER.

The annual dinner of the Institution of Electrical Engineers was held at the Criterion on Wednesday last. Dr. John Hopkinson (president) was in the chair, being supported on his right by the Duke of Norfolk, the Postmaster-General. Amongst the other distinguished guests may be mentioned Mr. J. Wolfe Barry, C.B. (president of the Institution of Civil Engineers), Captain W. de W. Abney, R.E., C.B., F.R.S. (president of the Physical Society), Mr. E. Windon Richards (president of the Institution of Mechanical Engineers), Dr. E. Frankland, D.C.L., F.R.S. (foreign secretary of the Royal Society), Sir W. H. White, K.C.B., Mr. W. H. M. Christie (Astronomer Royal), the Marquis of Tweeddale, Prof. J. Dewar, F.R.S., Rear-Admiral W. J. L. Wharton, C.B., F.R.S., and Prof. Herkomer, R.A. During the dinner a band under the able direction of Mr. C. Thomas discoursed an excellent programme of music. Our appreciation of the entertainment was considerably enhanced by a neighbour on our right who, with a gift of prophecy, foretold the gist of speeches to come.

After the usual loyal toast, proposed by the PRESIDENT, and permission to smoke had been given, Prof. AYRTON rose to solve an old problem. He proposed "The Learned and Engineering Societies" He thought the juxtaposition of the two adjectives, "learned and engineering," was unhappy, as it raised a question as to whether an engineering society was not a learned society. After a few lucid explanations of similar intricate problems we were allowed to conclude that the adjectives were adjectives of quality and not of distinction. He thought that both the Institution of Civil Engineers and the Royal Society were to be most highly commended for the assistance given to their offspring. He referred to the fact that the Electrical Engineers had not yet a home of their own, and he hoped that when the time came for them to move from the parent society the goodwill would not be broken on parting. He also referred incidentally to a wish on the part of the Physical Society to co-operate in certain matters with the Institution of Electrical Engineers.

Dr. E. FRANKLAND, in responding for the Royal Society, acknowledged the interdependence between abstract and applied science. He was glad to see so many Fellows of the Royal Society taking prominent parts in the practical development of the electrical industry.

Mr. J. WOLFE BARRY said that the engineering profession was laying by a vast store of knowledge, thanks to the records of the various societies. The history of what had been accomplished in the past was most valuable to all, but perhaps the records of failures were even more useful. Thus the three engineering societies—Civil, Electrical, and Mechanical—had a gross membership of over 11,000, which showed the enormous number of trained men endeavouring to advance engineering knowledge.

Mr. ALEXANDER SIEMENS, in proposing the toast of "Our Guests," coupled with the name of the Duke of Norfolk, spoke of the financial aid required in the carrying out of large schemes. This assistance was most essential, as without it the knowledge of engineering and abstract science could not be attained. He was not so sure that the knitting of nations together by telegraphic communication was an unmixed blessing. He thought that some of the evils laid to the door of free trade were rather caused by the increased facility of communication.

The Duke of NORFOLK, in reply, said he believed people were better off when left alone; they were not benefited by being continually urged on. He was sorry to be responsible for much of that kind of thing. It might be thought that the Postmaster-General knew something of telegraphy, but those acquainted with English public life would not expect that. He felt it a great honour to be at the head of a department with a great work to carry out, and intimately connected with all scientific investigations and advances.

The Marquis of TWEEDDALE then proposed the toast of the evening, "The Institution," and in a short speech mentioned some of the uses to which electricity had been put.

Dr. J. HOPKINSON, the president, in responding, remarked that all present would agree that it was desirable for the world at large that the commercial supremacy of the British Empire should be maintained. That supremacy was initiated by our being the first to employ, on a large scale, the resources of coal at our disposal, and to-day it was maintained largely by the fact that coal was the basis of the means of communication and of most of our industries. If coal were to cease to be necessary for those purposes, would the Empire still maintain its commercial supremacy? He doubted it. In the Falls of Niagara there was a waste of more power than could be derived from all the coal that could be raised throughout the world, and they well knew that there were many other falls in the world than those of Niagara. He ventured to say that it would be the work of

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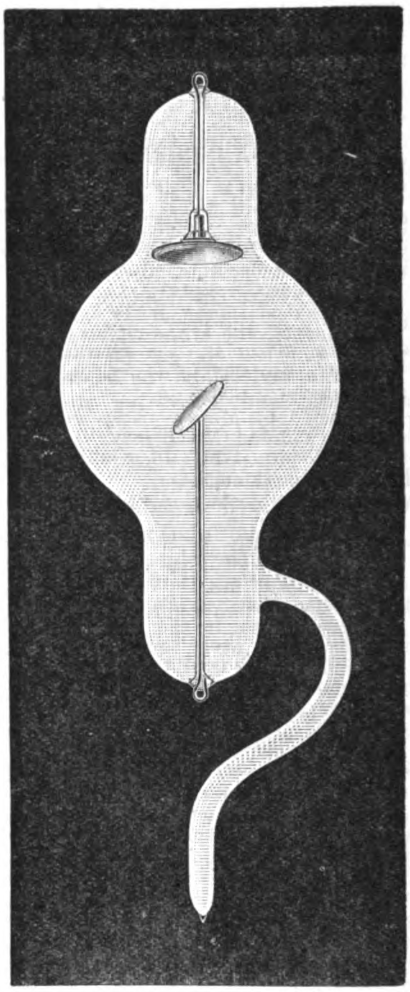
the engineer in future to utilise those falls for the acquisition and transmission of power for various purposes. He also referred to the comparative shrinkage of the earth, due to the increased facilities in rapid transit and communication.

The following is a complete list of those who were present:

Captain Abney, Mr. Addenbrooke, Mr. Alabaster, Mr. Albright, Mr. R. W. Allen, Mr. W. H. Allen, Mr. Andersen, Mr. Ansell, Mr. Ardron, Prof. Ayrton, Major Bagnold, Mr. Bailey, Lieutenant Bailey, Mr. Baldwin, Mr. Barr, Mr. Barry, Mr. Bathurst, Mr. Baylor, Mr. Bayly, Mr. Benedict, Mr. A. Berthgeil, Mr. E. Berthgeil, Mr. Biggs, Mr. Billington, Mr. G. Binswanger-Byng, Mr. M. Binswanger-Byng, Mr. Blackwell, Mr. Blenkarm, Mr. Blount, Captain Brett, Mr. Brockman, Mr. Bull, Mr. Carpmael, Mr. Carr, Mr. Christie, Mr. Clark, Mr. Clerk, Mr. Clirehugh, Mr. Cooper, Mr. Cluer, Captain Creak, Mr. Crompton, Mr. Crookes, Mr. Crowe, Mr. Cunynghame, Mr. Curra, Mr. D'Alton, Mr. Davis, Mr. Davies, Mr. Dawson, Mr. Devonshire, Prof. Dewar, Mr. Doherty, Mr. Down, Mr. E. Dowson, Mr. J. Dowson, Mr. Drake, Mr. Eck, Mr. Edmunds, Mr. Ellis, Mr. Epstein, Mr. Erskine, Mr. Esson, Mr. Fairfax, Mr. Fanta, Mr. Fawcus, Mr. Ferranti, Mr. Fleetwood, Prof. G. C. Foster, Dr. Frankland, Mr. Gabbett, Mr. de Galindez, Mr. Gaster, Mr. Gavey, Mr. Gibson, Mr. Gorham, Mr. Grindle, Mr. Grove, Mr. Hall, Mr. Hammond, Mr. Harrison, Mr. Hawkins, Mr. A. Heaviside, Mr. B. Heaviside, Prof. Herkomer, Mr. Hesse, Mr. Hibberdine, Mr. Hill, Mr. Hookey, Dr. Hopkinson, Prof. Housman, Mr. Howard, Mr. Hughes, Prof. Hughes, Mr. Ince, Mr. Jackson, Dr. Jackson, Mr. Jacob, Mr. J. Jenkin, Mr. T. C. Jenkin, Dr. Keith, Mr. Kempe, Mr. Kempster, Mr. Kolle, Mr. Lamb, Mr. Langdon, Mr. de Lattre, Major Leese, Mr. Lloyd, Mr. Lord, Mr. McDougall, Mr. Mackenzie, Mr. McMahon, Mr. Madgen, Sir H. Mance, Mr. Marsh, Mr. May, Captain Maunsell, Mr. Mavor, Mr. Meredith, Mr. Mordey, Mr. Mott, Mr. Morse, Mr. Mountain, the Duke of Norfolk, Mr. Offor, Mr. Cunliffe Owen, Mr. G. N. Partridge, Mr. G. W. Partridge, Mr. Parshall, Mr. Pearson, Prof. Perry, Mr. Phillips, Mr. Pomeroy, Mr. Preece, Mr. Rausch, Mr. T. Rawlins, Mr. W. Rawlins, Mr. Rawson, Mr. Reason, Mr. Reed, Mr. Reimers-Eonverg, Mr. Renshaw, Mr. Richards, Mr. Roberts, Mr. Robinson, Mr. Rosenthal, Mr. Samuelson, Mr. Sherrin, Mr. Siemens, Mr. Sinclair, Mr. Smith, Mr. F. Smith, Mr. Snell, Mr. C. E. Spagnoletti, Mr. J. E. Spagnoletti, Mr. H. C. Sparks, Mr. T. A. Sparks, Mr. C. P. Sparks, Mr. C. P. Sparks (friend), Mr. Stearn, Mr. Stewart, Mr. Still, Mr. Stothert, Mr. Mr. Stottner, Mr. Stroh, Captain Stuart, Mr. Stuart, Mr. Swan, Mr. Swinton, Prof. Thompson, Mr. Thomson, Mr. Tree, Mr. Trezise, Mr. Turrell, Marquis of Tweeddale, Mr. Walby, Mr. Wallace, Mr. Wallace Jones, Prof. Walmsley, Mr. Walpole, Mr. Ward, Mr. G. R. Webb, Mr. F. H. Webb, General Webber, Mr. Wharton, Admiral Wharton, Sir W. H. White, Mr. Wickham, Prof. Willis, Major Woodley, Mr. Wooler, Mr. Woods, Mr. Wordingham, Mr. Worsfold, Mr. Wright, Mr. Young.

TUBES FOR "X" RAY WORK.

The Edison-Swan United Electric Light Company, Limited, are now putting tubes for "X" ray experiments on the market. We illustrate herewith the form of these tubes, the quality of which is guaranteed by the previous experience of the company in similar work. The tubes can be had in several sizes from any of the showrooms of the company.



Edison-Swan "X" Ray Tube.

PHYSICAL SOCIETY, Nov. 13, 1896.

Captain Abney (President) in the Chair.

A paper on "**Some Experiments with Rontgen Radiation,**" by **Prof. Threlfall** and **Mr. Pollock**, was read, in the absence of the authors, by the **Secretary**. The authors described a form of Crookes's tube which, while it can be made by anyone capable of the most elementary glass-blowing, gives a plentiful supply of Röntgen rays. The results of their experiments may be summed up as follows: (1) The Röntgen radiation does not consist in the projection of gaseous matter, or if it does, the amount of such matter involved is extraordinarily small. (2) The Röntgen radiation does not consist in the projection of ether streams having a velocity above a couple of hundred metres per second; this is true whether the radiation takes place in air or in benzene. (3) The properties of the ether, regarded as determining the velocity of electromagnetic waves, are not greatly changed (*i.e.*, not at all within the experimental limits) by the Röntgen radiation, and this applies alike to the ether in air and in benzene. (4) A selenium cell composed of platinum electrodes and highly purified selenium is affected by Röntgen radiation to an extent which is comparable with the effect produced by diffused daylight. (5) No permanent or temporary E.M.F. is set up in a selenium cell by the Röntgen radiation. The authors have come to conclusion (1) by exposing an exhausted tube placed in parallel with a spark-gap so adjusted that the spark just passes over the gap rather than through the tube to the Röntgen radiation. They find that a vacuum tube in parallel with a spark-gap is very sensitive to changes in pressure within the tube. Conclusions (2) and (3) were arrived at by using Michelson's arrangements for the interference of two beams of light.

Mr. Shelford Bidwell said he had made some experiments on the effect of Röntgen rays on the resistance of selenium, but with a negative result, although he could have detected a much smaller change than that found by the authors. It might be that this difference was due to the tube, for in his experiment the radiation started from a platinum plate within the tube, while in the authors' arrangement the radiation starts from where the cathode rays strike the glass of the tube.

Prof. Silvanus Thompson said there were a number of points with reference to the Röntgen radiations which required clearing up. For instance, the suggestion that they were vortices in the ether had not been tested. Again, Lafay says that if the rays are passed through a metal screen which is charged with electricity, then the rays can be deflected by a magnet. He (Prof. Thompson) had not been able to repeat this experiment; neither had he that of Galitzin on the polarisation of the rays by tourmaline. The statement of Prof. J. J. Thomson that under the influence of the radiation paraffin became a conductor had not been satisfactorily proved. As to the wave-length, while some observers obtained values about one-tenth that of the extreme violet, another had obtained a value greater than that of the extreme red. Everyone who had worked with Crookes's tubes had found that the resistance is always greater for a spark in one direction than the other, and also varies with the battery power employed. Lenard, adopting Hertz's arrangement, used as anode a cylinder surrounding the cathode (a disc), the idea being that by using such a symmetrical arrangement the cathode radiation was more homogeneous. It might be advisable when seeking to produce homogeneous Röntgen rays to adopt such a symmetrical arrangement.

The **Chairman** said that since no selection was made with reference to the announcements which appear in the *Comptes Rendus*, it was frequently found that these announcements were wrong.

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Mr. Bryan then read a paper by himself and Dr. Barton on **"The Absorption of Electrical Waves along Wires by a Terminal Bridge."** The authors employ for the generation of the oscillations an arrangement of the same description as that used by Bjerknes, the waves being propagated along two parallel wires about 116m. long. In order to measure the waves, they use a small electrometer with an uncharged needle. The resistances employed to form the bridge consist of pencil marks on ground glass. Bridges of three resistances have been examined, one having as nearly as may be the resistance necessary, according to Heaviside's theory, to give complete extinction of the reflected wave, and of the others one was of higher and the other of lower resistance. In each case the results confirm the theory, and it is thus experimentally proved that by using a bridge of this description the reflected train of waves can be completely extinguished.

Mr. Blakesley asked if the authors had made any allowance for the capacity of the wires.

Mr. Campbell asked if the resistances given were expressed in ohms or in electromagnetic units.

Mr. Bidwell asked if the authors had found that the pencil-trace resistances obeyed Ohm's law. He had found that if you balanced with one cell in the battery circuit, then on increasing the battery power to two cells the resistance altered.

Mr. Appleyard suggested that the variation was caused by the contacts at the ends not being good.

Mr. Campbell said the same variation occurred in the case of mixtures of clay and plumbago where the contacts were quite good.

Mr. Carter suggested electroplating the ends to give good contact.

Mr. Bryan, in his reply, said that they had not considered the question of capacity, and that in their case they did not require to know the resistance very accurately.

The society then adjourned till November 27.

LEGAL INTELLIGENCE.

CASE AGAINST THE DUBLIN CORPORATION.

In the Southern Divisional Police Court at Dublin, on November 23, a case was heard, before Mr. Byrne, Q.C., in which the Corporation of Dublin were summoned at the instance of Messrs. Oetzman and Co., Limited, for having, while being the undertakers within the meaning of the provisional order granted by the Board of Trade under the Electric Lighting Acts, 1882 to 1888, to the Corporation of Dublin, made default in supplying energy to the complainants, who are occupiers of premises at 61, Grafton-street. The summons also set out that the penalty for such default was £2 a day, and it was claimed that the default has extended over a period of 200 days.

Mr. R. Day (instructed by Messrs. Casey and Clay) appeared for Messrs. Oetzman; and Mr. Macinerney, Q.C. (instructed by Messrs. H. Bonass and Ignatius Rice), appeared for the Corporation.

Mr. Day having read the summons,

Mr. Macinerney said he objected to its reception unless the date of the alleged default was put in.

Mr. Day said, if necessary, he would have the summons amended and December 31, 1895, put in as the date. He proceeded to read Section 18 of the Dublin Electric Lighting Act, from which it appeared that the Corporation were bound to maintain the mains laid down in the streets mentioned in the second schedule appended, of which Grafton-street was one. He submitted, on the reading of this and other sections in the Act, that the inhabitants of the streets in this schedule had the first claim on the energy supplied by the Corporation. The twenty-fourth section provided that, whenever the undertakers made default in the supply of energy to persons whom they might be required to supply energy under the order, they should be liable to a penalty of 40s. for each default. The complainants had given the requisite notice to the Corporation that they required the supply, and the Corporation accepted that notice and promised repeatedly to supply the energy, but up to the present they had not done so. Counsel read correspondence that had passed between the complainants and the Corporation, commencing on January 11 1895, on the subject of the failure to supply the required energy. The Corporation, he said, definitely promised to have it ready for the horse show of 1895. Again, in answer to another application on November 4 the Corporation gave them a definite promise on November 13, 1895, in a letter signed by Mr. Henry Campbell, town clerk, which stated : "The Electric Lighting Committee are making such arrangements as will enable them by the end of the year to supply the electric current to you and many other applicants." This promise was not fulfilled, and the complainants wrote again pointing out that the failure to supply the electric current to them was most disastrous to their business, as they had a sale commencing on the 3rd proximo. A letter was received in reply from Mr. Campbell on January 12 in which he stated that "the Corporation have now commenced the work of making connections with their electrical mains. There were 52 applications received previous to yours, and some little delay must therefore take place before the necessary supply can be given to you." Complainants wrote again on the 24th pointing out that this was the first they had heard of the 52 previous applications. An answer was received acknowledging receipt of that letter on the 28th, and stating that it would be laid before the committee On January 31 they received an answer from the Corporation referring them to a previous letter. Complainants then wrote : "We are greatly astonished at the treatment we received at your hands in respect of the electric lighting question. We may safely claim that our numerous communications to you have been decidedly to the point," and they further asked for some definite understanding on the matter. On February 7, 1896, the Corporation replied : "The new connections are being made as fast as possible, and hope to allow you to have it within a fortnight." Nothing having been done, on August 4 complainants again wrote, strongly protesting against their treatment by the defendants, as it was now some 20 months since the first application was made, and threatening to place the matter in the hands of their solicitor. The Corporation, in reply, wrote on August 14, saying that they were anxious to do everything in their power for their firm and other firms, but under the circumstances must ask the kind indulgence of complainants for some time longer. They also pointed out that they were placed in a difficulty owing to the non-delivery of a new engine. On August 22 complainants again wrote, stating that the answer and explanation of the Corporation were very unsatisfactory. Counsel read further correspondence, from which it appeared that on August 29 the Corporation offered to supply 52 lights, but Messrs. Oetzman had refused to take any number less than 75 However, at a later date—October 7—they wrote, saying they would accept the 52 lights at once and the balance later on, but they did not succeed in getting them.

Mr. Macinerney, Q.C. : Because in the meantime we had given them to someone else.

Mr. Day having concluded the reading of the correspondence, said the complainants had come to the conclusion that the Corporation were merely trifling with them, and so they had brought the Corporation before the Court, claiming compensation for the loss that had been caused to them in their business. It was owing to the fact that the Corporation had extended their operations beyond the limited area specified in the schedule, and which was to have been a first charge on the energy, that they were left without the supply for their establishment

Mr. Byrne suggested that the case might be allowed to stand for a month, the Corporation undertaking in the meantime to supply the required energy.

Mr. Day said he understood it only took three hours to connect the installation of Messrs. Oetzman with the distributing mains.

Mr. Macinerney said the summons was brought to recover a penalty which, he submitted, could not be recovered. No one could be more anxious than the Corporation to spread the electric lighting area over a wider area, but, owing to circumstances, they were prevented from extending the supply. They would supply it to Messrs. Oetzman next Wednesday in the ordinary way, altogether regardless of the result of this proceeding. The notice that had been served by complainants was not a compliance with the section, and under it the penalties applied for could not be recovered.

Mr. Day admitted that, strictly speaking, they had not served the notice required by the Act, but he contended that the correspondence afforded sufficient ground for their proceeding as they had done in this case. The Corporation treated them for two years as persons who had made a proper application.

After further discussion, it was agreed to allow the case to stand for a week.

Mr. Macinerney said he wished it to be understood that the giving of the electric light to Messrs. Oetzman on the following Wednesday was only giving it to them in their turn, and had nothing to do with this case.

The case was adjourned for a week.

ACTION BY THE EDISON GENERAL ELECTRIC COMPANY.

In the Judicial Committee of the Privy Council, on November 21, before Lords Watson, Morris, Hobhouse, and Sir R. Couch, the case of the Edison General Electric Company *v.* the Westminster and Vancouver Tramway Company, the Bank of British Columbia, and others, was heard.

This was an appeal from a judgment of the Supreme Court of British Columbia, the appellants being the Edison General Electric Light Company, who sought to set aside a judgment of the Colonial Court in favour of the bank for a sum of 261,217dol., with the certificates registering the judgments against the lands of the tramway company. The Edison Company, who are the appellants, first brought the suit before a judge, who dismissed it with costs, and the same fate awaited an appeal to the Supreme Court. The suit was founded upon the first section of the Consolidated Statutes of British Columbia, which provides that if a person who is insolvent and by collusion with a creditor consents to a judgment in favour of a creditor which gives that creditor preference over others, such judgment shall be null and void. It was argued on behalf of the bank that the object of the judgment, as shown by the evidence, was to enable the bank to reconstruct and carry on the tramway company, and that there was no fraudulent intent, whereas there must be fraud to bring the case within the statute.

Sir R. Couch now read the judgment of the Court who sat when the case was argued—namely, Lords Hobhouse, Macnaghten, and Davey, and himself. Their Lordships held that it was not disputed that the tramway company was insolvent at the date in question, and that they had consented to the judgment. It was plain from the evidence that there was an agreement which amounted to collusion between the respondent bank and the tramway company, the effect of which was that the bank should have a judgment, and that their judgment should have priority to the appellants' judgment, the object being, as Mr. Ward said, that the bank should be in a position to protect the company and carry it on. The case, therefore, came within the provision of the section. As to fraud, the act of collusion for the purpose of giving priority to one creditor over another was treated by the statute as

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a fraudulent act. Their lordships were therefore of opinion that the statute made the bank's judgment null and void and they would advise her Majesty to reverse the decree of the Supreme Court, and to declare the judgment in favour of the bank null and void, and to order the executions and certificates founded thereon to be set aside and cancelled, the costs of the suit, including costs of appeal to the Supreme Court, and the costs of this appeal, to be paid by the bank.

DISPUTED LIABILITY FOR ELECTRICAL WORK.

In the Westminster County Court, on November 25, before his Honour Judge Lumley Smith, Q.C., the case of Hooper *v.* Graves was heard.

The plaintiff, an electrical engineer, residing at Marylebone-road, sought to recover payment of a balance of account of £3. 15s. for electric lighting work done to the order of the defendant at his flat in Victoria street.

The **Defendant** admitted that the work was done, but contended that his wife was liable on her separate estate, as it was she who gave the order. He further contended that a good deal of the wiring had to be done over again, and that in any event the plaintiff's charge was excessive.

The **Plaintiff** denied taking any instructions from the wife, and his **Honour** gave judgment for the plaintiff for the full amount claimed with costs.

COMPANIES' MEETINGS AND REPORTS.

EDISON AND SWAN UNITED.

An extraordinary general meeting of the Edison and Swan United Electric Light Company, Limited, was held on Tuesday at the Cannon-street Hotel, E C., Mr. J. Staats Forbes presiding, to consider the resolutions for amalgamating with the Company the undertaking of the Manchester Edison-Swan Company.

The **Secretary** (Mr. Gover) read the resolutions as follows: "(1) That it is expedient to acquire and take over by way of amalgamation the undertaking of the Manchester Edison Swan Company, Limited. (2) That the draft agreement for the purpose expressed to be made between John Edwin Sharples, on behalf of the Manchester Edison Swan Company, Limited, of the one part, and this Company of the other part be and the same is hereby approved, and that the directors be and they are hereby authorised to execute an agreement in the terms of the said draft, and to carry the same into effect, with full power to assent to any modifications therein which they think expedient in the interests of this Company, either before or after the execution thereof. (3) That the directors be and they are hereby authorised, upon the adoption of the said agreement by the liquidator of the Manchester Edison-Swan Company Limited, with the sanction of a special resolution of the said company, to appoint Mr. W. P. James Fawcus, one of the directors of the said company, to be a director of this Company. (4) That for the purpose of redeeming the existing 4½ per cent. debenture stock, and providing for the extension of the business, the directors be and they are hereby authorised to create and issue perpetual debenture stock of the nominal amount of £350,000, carrying interest at the rate of 4 per cent. per annum, and redeemable at the option of the Company at 110, and to be constituted and secured by trust deed in such form and manner as the directors think expedient. (5) That the directors be and they are hereby authorised to issue any of the said new debenture stock at such times and upon such conditions as they may think fit, in exchange for any of the existing debenture stock, or otherwise as they may approve."

The **Chairman**, in moving the adoption of the resolutions, referred to the history of the establishment of the Manchester Company. It was not a proposal to buy out certain people, or to give them so many sovereigns for their business and their goodwill. The Manchester Company had been, so to speak, licensees of the parent company, the bargain having been that, in consideration of paying £13,000 to the Edison and Swan Company and purchasing all their lamps from that company, the Manchester Company were to trade in their own way on their own account in a limited area, from which the Edison and Swan Company were themselves restrained from trading. That agreement was made in the "dark ages"—at any rate of electric lighting—and the course things had taken had not been quite what was then anticipated. Owing to this, added to the fact that the agreement was very complicated, questions kept on arising until the patents expired, when the Manchester Company claimed the right to do what they chose both in and out of their area, and the Edison and Swan Company did the same. The competition bade fair to damage both of them, and therefore they thought it wiser to see whether their differences could not be adjusted by uniting their interests. This was the underlying principle of the proposed agreement, which was the outcome of a great deal of correspondence and negotiation. The Manchester Company had £30,000 in the lamp and lamp-fitting business, and on this amount they had paid a dividend (5 per cent.) for some years. In addition, the Manchester Company had a concession for an electric lighting business which was now being carried on at Altrincham. They seemed to be doing very well with this part of the business, on which they had also expended £30,000, which had been raised by loans. The Altrincham business had been going on for two years, and it bade fair to be profitable. When negotiations were being carried on, the Manchester Company had increased from 3,000 or 4,000 to 10,000 lamps, and during the last four or five months the 10,000 had increased to 14,000. The Manchester Company would have preferred to take £30,000 from the Company and go out, but the Edison and Swan Company preferred that they should remain partners with them; and eventually the Manchester people agreed to take £30,000 in the Company's shares and to accept debenture stock which it was proposed to issue for their £30,000 of loans. If carried out, the agreement would make the Manchester Company not only partners with this Company, but would also bring them a business which was already fairly profitable, and which could be made more profitable, and it would also remove the dangers of competition. The bargain made with the Manchester Company was based on that company's last balance-sheet, subject to correction up to the date of transfer. On their several undertakings they made a gross profit last year of £7,491, and the Edison and Swan Company had satisfied themselves respecting the correctness of this statement. They proposed to hand over to the Manchester Company 10,000 of their £5 shares with £3 each paid up in exchange for the Manchester Company's 20,000 £1. 10s. shares paid, leaving these shares saddled with a liability for calls of £2 each, like the Edison and Swan Company's own A shares. With respect to the proposed issue of debenture stock, they were now encumbered with a debenture debt of £100,000, which, however, was redeemable at six months' notice. It was more advantageous in the interests of the shareholders for them to issue debenture stock than to call up the unpaid capital, because their shares with £3 paid on them were quoted at a discount. They ought not to be, because they had been paying pretty regularly for some years a dividend of 5 per cent., but the fact remained, and it was therefore not expedient to call up capital to be immediately quoted at a discount. In the resolutions reference was made to creating and issuing £250,000 of debenture stock, but they did not want anything like this amount. It was, however, an advantage to create at once a stock with equal rights of sufficient amount for their purposes. If the resolutions were approved, they intended to give notice to redeem the £100,000 of debenture stock outstanding, but to invite the holders of it to exchange into the proposed 4 per cent. stock. The uncalled capital in the ordinary shares increased the value of the debentures, but if any of the shareholders disliked the liability to a call the Board had power, and were willing to exercise it, of relieving them of that liability by taking payment in full. They could not, however, give them 5 per cent. for the money when they could borrow it at less, but equitable terms might be arranged.

Mr. Killingworth Hedges referred to the Manchester Company having done installation work and derived some considerable profit from it. That was a point to be considered, because the Edison-Swan Company could not undertake such work without going into competition with their best customers for lamps and fittings. As to the central-station work, the Company once undertook it, but dropped it as inexpedient. He would have liked more details as to Altrincham. They knew such work was only for a period, and not for all time, and the conditions of the local authority as to surrender or purchase were sometimes very severe. That greatly affected its value to take over. He would also like to ask what became of the B shares.

The **Chairman** said that Mr. Fawcus was at the Manchester meeting—this was fixed for the same day—or no doubt he would have had something to say in reply to Mr. Hedges on behalf of the business that had been undertaken. It was the intention of the Company as heretofore to keep clear of installation work, but as to current generating (central station) work there might be places beneath the notice of the great companies which it would be worth their while to undertake. The B shares had never more than a nominal value, and would be dropped. It simplified the accounts, and came to the same thing as regarded profits.

Mr. Hedges again enforced the necessity of not undertaking any work which would put the Company on bad terms with electrical engineering firms.

After some further questions on points of detail had been answered, the **Earl of Lichfield** seconded the resolution. He believed he was the only director who was on the original Board, who were responsible for the agreement which the chairman had said was made in the dark ages. At the time it was made it seemed a very desirable agreement, the idea then being to have a quantity of subsidiary companies. Fortunately, perhaps, it had turned out differently and he strongly recommended the resolutions proposed.

The resolutions were carried unanimously, and the meeting ended with the usual votes of thanks.

MANCHESTER EDISON-SWAN ELECTRIC LIGHTING COMPANY, LIMITED.

An extraordinary general meeting of this Company was held at the Memorial Hall Liverpool, on Tuesday for the purpose of considering a resolution for the adoption of a provisional agreement for the amalgamation of the Company with the Edison and Swan United Electric Light Company, Limited.

A copy of the provisional agreement was read by **Mr. Parkinson**, solicitor to the Company.

Mr Vernon K. Armitage, chairman of the Company, in moving its adoption, said the agreement was simplicity itself. The parent company were to give to the Manchester Company, subject to certain conditions as to debentures, etc., one £5 share of £3 paid up in return for two of their shares of £5 each, 30s. each paid up, and for that they were to take over the whole of the undertaking,

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relieving them of all their liabilities and taking over all their assets. One of several advantages which the amalgamation would secure was that it would prevent the annoyance caused to the shareholders by the continual fluctuations in the value of their shares on the Stock Exchange. Those fluctuations had been due not to changes in the intrinsic value of the shares, but to the fact that large holders of the shares died, and that executors or trustees, feeling it undesirable to continue to hold shares of which so large an amount remained uncalled up, sold out at any figure. The amalgamation with a large company would undoubtedly conduce to the stability of the shares on the Stock Exchange. The amalgamation would also be of service in the way of enabling the business to be carried on in Manchester on the lines which the directors had hitherto regarded as the most desirable. He regarded the proposed amalgamation as a very wise proposal, and hoped it would be agreed to unanimously.

The motion was seconded by **Mr. F. B. Ross** and unanimously adopted.

BROCKIE-PELL ARC LAMP COMPANY, LIMITED.

The statutory general meeting of the Brockie-Pell Arc Lamp Company, Limited, was held on Tuesday at the offices, 97, Queen Victoria-street, E.C., Lord Suffield presiding.

There was no resolution, but the **Chairman** said the Company went to allotment on August 14 last, and before doing this the directors were careful to see that the full working capital was secured. The directors set to work with the one view before them of manufacturing the lamps under the patents. Their engineer, Mr. Brockie, had designed special appliances and machinery which would ensure the rapid and accurate production of a better article than had hitherto been supplied to the public. The intention was to adopt a strictly interchangeable system in every part in the lamps of their make. All arrangements were being pushed on as rapidly as possible, and some of the machinery had already been delivered, while the remainder was now in transit. The directors had secured suitable manufacturing premises in Finsbury, and as the demand for the lamps was increasing, and the outlook for the future business was promising, they had, in taking these premises, borne in mind the probable extension of the Company's trade. Mr. Brockie and Mr. Pell had become permanently associated with the Company, and were giving their careful and constant attention to the many details incidental to the Company's business. The Board were taking into consideration the question of dealing with the foreign patents of the Company, which should prove a valuable asset.

Mr. Squibb asked whether the Board had taken any steps to obtain a quotation on the Stock Exchange

The **Chairman** replied in the negative, and the **Solicitor** (Mr. Crisp) said the reason was that the vendors' shares were too large a proportion, amounting to more than one-third of the capital.

In reply to **Mr. Bailey, Mr. Bennett Pell** said there were several contracts in hand, some being very important ones. Taking the places abroad first, there was the city of Durban, the capital of Natal; then another was being carried out at Johannesburg at the present moment. They had recently sent out a large number of lamps to a well-known mining company, the Mount Morgan, in Queensland, and several had been supplied to mines in South Africa. A very large number had been supplied in one way and another abroad. At home there was a contract for lighting the streets of Chester, a contract for an extension of lighting in South Shields, and another one for an extension of lighting in Taunton. In London there was one being carried out in a large district in the West end (Hammersmith) and the upper part of Regent-street, which had been recently lighted with their lamps; in fact, it was only completed last week Then there was a large district in the East-end—Shoreditch. Other contracts were under consideration at the present moment. Of course there were a large number of lamps besides, which had been supplied to various people, and they had recently been delivering lamps to some of the railway and dock companies.

After some conversation a vote of thanks to the Chairman was carried.

CONTINENTAL METROPOLITAN TRAMWAYS COMPANY, LIMITED.

An extraordinary general meeting of this Company was held on Tuesday at the Cannon-street Hotel, E.C., Mr. B. H. Van Tromp presiding.

The object of the meeting was to consider a resolution for winding-up the Company voluntarily under the provisions of the Companies' Acts, 1862 and 1867, and appointing Messrs. B. H. Van Tromp, G. Richardson, C. M. Davidson, and J. H. H. Duncan liquidators.

The **Chairman**, in moving a resolution to the above effect, said the Board had formulated a scheme for what they considered a fair and equitable division of the purchase-money, and they would, of course, take care to put in evidence, by affidavit of himself or the secretary, the result of the appeal which had been made to the shareholders. This would show the Court that the shareholders were practically almost unanimous with respect to the scheme. The purchase-money for the undertaking had been paid to the hour, and within a few hours of its receipt he and Mr. Richardson attended at the bank and deposited the money on thoroughly good security at interest which he thought was now carrying 3¼ per cent. The amount was nearly £400,000, and, therefore, it was producing at the rate of £12,000 a year, even at 3 per cent. They intended at the earliest possible moment to call a meeting to confirm the resolution now proposed, so that they might take the question before the Court immediately after the Christmas holidays. He hoped the Court would confirm the directors' scheme, but the question was whether under the articles of association they would have the power to do so.

After some consideration as to what would happen if that was not done, the resolution was seconded by **Mr. Richardson**, who said the sympathies of the directors were entirely in favour of the preference and preferred ordinary shareholders

Mr. Birks hoped the position of the ordinary shareholders would be properly represented to the Court.

The resolution was then carried unanimously.

ANGLO-FRENCH MOTOR CARRIAGE COMPANY, LIMITED.

The statutory general meeting of this Company was held on Tuesday at Winchester House, E.C., Mr. E. B. Ellice-Clark presiding.

The **Chairman** said negotiations were proceeding for acquiring a factory in France and the Company had already taken premises in Birmingham. There was no resolution except a vote of thanks

CONTRACTS FOR ELECTRICAL SUPPLIES

CONTRACTS OPEN.

Posen.—Tenders will be received on December 4 for 430 telegraph posts for the State Railways Particulars 50pfg. (6d.). Address, Königl. Eisenbahn Direktion Rechnungsbureau, St. Martin 40, Posen.

Brussels.—Tenders will be received at the Hôtel de Ville, Brussels, on December 11 for the supply of pipes and of some other stores necessary for the Municipal Electric Lighting Department during the forthcoming year.

Valdevenas (Spain).—Offers will be received at Valdeveñas, in the province of Ciudad Real, on November 29 for the erection of a town electric lighting station, etc. Application is presumably to the Local Authorities, but no additional details are to hand up to the present.

Paris.—The French Telegraphic Authorities will receive tenders at 103 Rue de Grenelle, for telephonic cables, cotton and lead sheathed, and for transport of telegraphic materials. The date is December 8, but application to tender must be made at once (November 28).

Karlsruhe.—Tenders will be received on January 2 next for an electric lighting installation for the railway station and pier at Constance for the Grand Ducal Railway Authorities. Particulars are obtainable for 10 marks (10s) from the Generaldirektion, (Centralbureau) Grossh. Badischen, Staatseisenbahnen, Karlsruhe, Germany.

Dublin.—Tenders are required for the supply of general stores and sundries during year ending December 31, 1897, for the Dublin United Tramways Company. Forms of tender (price 1s. each), conditions, and all information can be obtained and patterns seen at the Company's Offices, 9, Upper Sackville-street, Dublin, until the 30th inst. Tenders, sealed and marked outside "Tender for Stores," and addressed to the Chairman, to be lodged with Mr. Wm. Anderson, secretary, by 30th inst.

Bury.—The Corporation are prepared to receive tenders for the wiring of the municipal offices, Bank-street and Parson's lane, Bury Copy of specification and form of tender may be obtained on application at the office of the Borough Engineer, and on payment of a deposit of 10s. 6d, which will be returned on receipt of a bona fide tender. Sealed tenders, endorsed respectively "Wiring—Bank-street," "Wiring—Parson's-lane," to be delivered at the office of Mr. John Haslam, town clerk, on or before noon on November 30.

Hanley.—The Corporation require tenders for air-compressors (alternative arrangements driven by steam and by electric motors), and alternating-current electric motors at the sewerage works. Full particulars, specifications, bills of quantities, and forms of tender may be obtained at the office of Mr. Joseph Lobley, borough engineer and surveyor, Town Hall, Hanley. Contracts will only be given to firms paying the standard rate of wages Sealed and endorsed tenders must be sent to the Borough Engineer before Monday night, 30th inst.

Deptford.—The Commissioners of Baths and Wash-houses for the parish of St. Paul, Deptford, invite tenders for proposed electrical installation at the public baths, now in course of erection. Specification, form of tender, and particulars may be obtained at the offices of the architect, Mr. Thomas Dinwiddy, Greenwich, and 5, Whitehall, S W., on payment of £5 deposit, to be returned on receipt of a bona fide tender. Sealed tenders to be delivered to Mr. Arthur Huntley, clerk, Vestry Offices, 20, Tanner's-hill, Deptford, before 4 p.m. on 30th inst.

Copenhagen.—Provided the City Council will vote for spending the necessary amount, an electric station is to be built in Vesterbro, Copenhagen, and tenders are invited for the delivery of (1) boilers, (2) mechanical and electrical plant, and (3) network, in accordance with the description. Conditions and plans to be had upon application to the Electrical Station, 30, Gothersgade, Copenhagen. For each specification a fee of 50 kroner is charged, which is returned on acceptance of the tender. Tenders will be received at the office of the fourth division of the Magistracy until December 4 at 12 noon.

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London, N.—The Great Northern Railway Directors are prepared to receive tenders for the supply of new and the purchase of old stores for 12 months from January 1 next. A list of the contracts, and separate forms of tender for each contract, may be obtained on application to Mr. Martin, the stores superintendent, Doncaster, by whom every information will be furnished. The patterns of telegraph and electric lighting material will be exhibited at the Telegraph Stores, Retford, and the company's samples and patterns cannot be sent to contractors for inspection. Tenders addressed to the Stores Committee, marked on the outside with a description of the stores tendered for, must be sent to the Company's Offices at King's Cross, in the envelopes specially provided, so as to be received not later than 10 a.m. on December 5.

York.—The Corporation invite tenders—(Section A) supply and erection complete of plant in a central electric lighting station; (Section B) supply, laying, and connecting complete of a system of mains; (Section C) supply, erection, and connection of arc lamps; (Section D) running the whole system for a period of years. The whole work is to be in accordance with the specifications and drawings prepared by Prof. Alexr. B. W. Kennedy, M.I.C.E., the consulting electrical engineer to the Corporation of York. Firms willing to undertake the whole or any section of above work may obtain copies of the specifications and drawings on application to Mr. William Giles, acting town clerk, Guildhall, York, and on making a deposit of £2. 2s., which will be returned on receipt of a bona fide tender. Sealed tenders, endorsed "Electric Lighting," to be delivered by 30th inst.

Southampton.—The Corporation invite tenders for the supply and laying of (*a*) insulated electric mains, (*b*) conduits and drawing-in boxes. Specifications and forms of tender can be obtained at the Municipal Offices, Southampton, or at the offices of the engineers, Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster, on payment of a fee of £3 3s., which sum will be returned on receipt of a bona fide tender. The contractor will be required to pay not less than the minimum standard rate of wages for the time being in each branch of the trade. The contractor whose tender is accepted shall enter into a formal agreement, under seal, with sufficient sureties for the fulfilment of contract. Sealed tenders, endorsed "Electricity Supply, Tender for Contract No. 2," must be sent to Mr. George B. Nalder, town clerk, Municipal Offices, Southampton, at or before 12 noon on December 4.

Southampton.—The Corporation require tenders for the erection of buildings for an electric generating station, including engine-house, boiler-house, pump-room, and offices, chimney shaft and flues with accessories thereto, to be situated on the ground belonging to the Corporation, comprising and adjoining the present electric light station between Back-of-the-Walls and Canal-walk. Specifications, quantities, and form of tender can be obtained and the drawings can be seen at the Municipal Offices, Southampton, or at the offices of the engineers, Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster, on payment of a fee of £3. 3s., which sum will be returned on receipt of a bona fide tender. The contractor will be required to pay not less than the minimum standard rate of wages for the time being in each branch of the trade. The contractor whose tender is accepted shall enter into a formal agreement, under seal, with sufficient sureties for the fulfilment of contract. Sealed tenders, endorsed "Electricity Supply, Tender for Contract No. 1," must be sent to Mr. George B. Nalder, town clerk, Municipal Offices, Southampton, at or before 12 noon on December 4.

RESULTS OF TENDERS.

Southampton.—For lighting the municipal offices and Guildhall by electricity, for the Corporation. Mr. J. H. Lee, electrical engineer:

	A.	B.	C.	D.
E. T. Fiford and Sons	£239	£131	£0 6 0	£1 9 0
A. Ford Lloyd and Co.	225	*105	0 5 0	1 0 0
F. Shalders	231	122	0 2 6	0 16 6
Sanby and Co.	*212	119	0 15 0	1 7 0

Electrical engineer's protecting tender, £354.

A. Municipal offices. B. Guildhall and police offices. C. Extra switches. D. Extra lights. * Accepted tenders.

BUSINESS NOTES.

Devonport.—The Corporation have adopted electrical fire-alarms in the town.

Western and Brazilian Telegraph Company.—For the past week the receipts were £2,720.

Bristol.—The proposed scheme for the extension of the tramways has been approved by the ratepayers.

Paris.—The Claret-Viulleumier system of electric traction, which was recently adopted, is reported to be giving great satisfaction.

Morecambe.—The Urban District Council have advertised their intention to apply to the Board of Trade for an electric lighting provisional order.

Harrogate.—The Corporation have decided to light the interior and exterior of the new lavatories being built opposite the Prospect Hotel with electricity.

Kingston.—The Corporation having erected some artisans' dwellings, they have decided to fit them up with the electric light and to include the charge for it in the rent.

Electric Light at Olympia.—"Olympia" has been offered for sale by auction, but no one would buy. It was mentioned that the electric light installation itself cost £30,000.

British Pioneers' Exhibition Syndicate, Limited.—This Company has been formed, with a capital of £10,000 in £1 shares, to acquire and carry on the British Industrial Exhibition.

St. George's, Hanover-square.—The work of rearranging and reinstalling the wiring at this church, where the recent fire took place, has been entrusted to Messrs. Drake and Gorham.

Ayr.—The Town Council have appointed a committee to consider a proposal to support a company which is prepared on certain conditions to construct a system of electrical tramways for the city.

Handsworth.—At the Urban District Council meeting, Mr. Haynes gave notice that at the next meeting of the Lighting Committee steps be taken by the Council to light Woodhouse with electric light.

Windsor.—Motorcars are to be excluded from the Long Walk, which is used by the Queen and the Royal Family when proceeding to and from Windsor Castle, Cumberland Lodge, and other places in the Great Park.

Hull.—Mr. R. Hammond, having reported generally in favour of the scheme proposed by the Electric Lighting Committee last June, that committee recommend the Council to empower them to carry it into effect.

Personal.—Mr. C. L. Heath, lecturer on engineering subjects at the Central Science Schools, Sheffield, has been appointed chief lecturer on engineering at the Hull Technical Schools at a salary of £250 per annum.

Electrolytic Plating Apparatus Company, Limited.—This Company has been registered, with a capital of £50,000 in £1 shares. The registered address is St. Paul's-chambers, The Bridge, Walsall, Staffordshire.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended November 22 amounted to £1,183, as compared with £1,067 in the corresponding week of the previous year, being an increase of £116.

Bury.—The Electric Lighting Committee consists of the following gentlemen: the Mayor; Aldermen Brierley, Hall, Hopkinson, and Parks; Councillors Ashworth, Butcher, Byrom, Collinge, Hall, Mellor, Pickup, and Ward.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ended November 20 were £1,872. 7s. 6d., compared with £1 848 14s. 3d. for the corresponding period of last year, being an increase of £23. 8s. 3d.

Greenwich.—The Blackheath and Greenwich District Electric Light Company are proposing to extend their supply to the whole parish of Greenwich, as well as to those of Charlton, Eltham, Lee, and Lewisham, and the liberty of Kidbrook.

Ipswich.—An electric plant has been laid down at the sewage works for the purpose of electrolysing sea-water in connection with the treatment of the sewage. The parliamentary notice of the Corporation electric lighting scheme has been published.

Glossop.—A letter was read at the Town Council meeting from Mr. W. H. Druce, consulting engineer, Manchester, offering to supply the Council with an estimate of complete scheme for lighting the town with electric energy, but it was not entertained.

Electric Light in the City.—The *City Press* has published an article on this subject to show that not so much saving after all has been effected by the substitution of electric light for gas in the City, and that the original scheme was too ambitious.

Water Power from Small Streams.—In the mountainous districts of France and Switzerland the value of the innumerable small streams is becoming more and more recognised. Although for the most part small, these streams descend from a great height.

Threlkeld.—The electric light was turned on at the granite quarries for the first time last week. The plant comprises steam-engine and dynamo combined, capable of giving 12,000 c.p. The plant was erected under the supervision of Mr. W. Borlase, electrical engineer.

Coventry Machinists' Company, Limited.—This Company has been registered, with a capital of £100, in £1 shares, to carry on business as cycle, carriage, and motorcar manufacturers, india-rubber manufacturers and merchants, engineers, machinists, fitters and founders, wire-drawers, etc.

Flamborough.—Notice has been given that an application is intended to be made under the Light Railways Act, 1896, to the Light Railway Commissioners for an order to incorporate a company to work and maintain the proposed light railway. Electricity is proposed as the motive power.

City and South London Railway.—The returns for the week ended November 22 were £1,017, compared with £946 for the corresponding period of last year, being an increase of £71. The total receipts for the half-year 1896 were £19,842, compared with £18,562 last year, being an increase of £1,280.

Dover.—Holy Trinity Church is to be installed with the electric light, and contracts have already been entered into. The cost of the work will be about £100. The installation is to be completed before Christmas. It is proposed to carry the electric light mains through the streets on the Dover Castle Estate.

St. Bernard (Switzerland).—The proposed electric tunnel railway will be 60 kilometres long (rather more than 30 miles); it will join Aosta and Martigny; the tunnel will be only about a mile and a half in length, but the gradients are very severe. The cost of its construction is estimated at £1,600,000.

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Penarth Tramways Syndicate, Limited.—This syndicate has been registered, with a capital of £4,000 in £10 shares, to obtain a provisional order for the construction of a tramway between Cardiff and Penarth, Glamorganshire, and to turn to account the same. Registered office: 124, Bute-street, Cardiff.

Dumfries —The Joint Committee of the county and burgh which administers the Weights and Measures Act have discussed a proposal to procure an autocar with which the inspector might make his journeys throughout the district, carrying the standard weights with him, but a final decision was not arrived at.

Newhaven (Sussex).—At the Rural District Council meeting a notification was read from the Local Government Board that an electric lighting company was applying for a provisional order for electric lighting at Rottingdean. It was stated that notice of such intention would be served on all the local bodies interested.

Michoacan and Pacific Railway Company, Limited.—This Company has been registered, with a capital of £60,000, in £10 shares, to acquire concessions granted, or to be granted, for railways, tramways, telegraphs, and telephones, and other works in the State of Michoacan, or elsewhere, in the Republic of Mexico.

Brazilian Submarine Telegraph Company, Limited.—The directors have declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, tax free, for the quarter ended September 30, payable on December 18. The transfer-books of this Company will be closed from December 11 to December 17, both days inclusive.

Max-Saturn Electrical Syndicate, Limited.—This syndicate has been registered, with a capital of £3,000 in £1 shares, to carry on the business of an electric power and light company in all its branches, and of electricians, mechanical engineers, suppliers of electricity, and electrical apparatus manufacturers. Registered office: 20, Ely-place, E.C.

Appointment Vacant.—There is a vacancy on the medical staff of the London Homœopathic Hospital, Bloomsbury, W.C, for a medical electrician. Applications and testimonials must be sent in for examination by the medical council not later than March 1, 1897, to Mr. G. A. Cross, secretary-superintendent, of whom further particulars can be obtained.

Isle of Thanet Light Railways (Electric) Company, Limited. This Company has just been registered, with a capital of £1,000 in £10 shares. Its object is to promote and obtain the necessary authority to make and maintain railways in Kent or elsewhere, and to carry on business as a tramway, omnibus, railway, and electric company.

Edison and Swan United Electric Light Company, Limited.—Mr. H. C. Gover writes to us: "Please kindly let me say for your information that this Company does not propose taking up 'installation work' This question is being put by some of our friends in connection with the absorption by this Company of the Manchester Edison-Swan Company."

Lancaster.—It was stated at the Town Council meeting that by the end of the financial year it was confidently expected that the electricity works would become a paying concern, and pleasure was expressed that the establishment of those works had not deteriorated the gasworks, which during the past six months also showed a satisfactory increase of profit.

Blackpool.—The Corporation have decided to spend £300,000 on promenade improvement scheme. Arc lights will be fixed upon what will be known as the Island footpath, and the whole roadway is to be illuminated with other electric lights, one of the fixtures of which will be ornamental brackets to carry the cable of the new overhead tramway system which is to be adopted.

Cheltenham.—Notification is given of an intended application to the Light Railway Commissioners for an order authorising the construction of a light railway from the Midland Station, Cheltenham, to the village of Winchcombe, Gloucester. It is stated that the proposed gauge of the line will not exceed 4ft. 8½in., and that "electricity, air, or other motive power," as may be agreed with the Corporation will be used.

Electric Driving of Drying Ovens.—At the briquette works of the Ilse Lignite Mine, near Bückgen, in the West Kottbus district, the Schulz drying-ovens, and also two new briquette presses, that make 120 revolutions per minute, have lately been driven by belt from electric motors of 50 h.p. and 75 h.p. The management is also taking into consideration the advisability of driving electrically the plate ovens for drying the coal-dust.

Newport.—The Corporation have given notice of intention to apply to Parliament for a batch of new powers in the next session. The Bill includes provision for raising additional money for extending the existing tramways to the docks, to Malpas, and along the Corporation-road on the east side of the river. Powers are sought to employ cables, steam, electricity, or oil as the propelling power, if it be thought necessary to supplant horses.

Testing Fees.—The London Commissioners of Sewers give notice of their intention to prescribe the undermentioned fees for the testing of consumers' wires and fittings agreeably to the provisions of No. 43 (A) of the regulations made by the Board of Trade under the Electric Lighting Act—viz., for a test not occupying more than two hours, 10s.; for a test taking more than two hours, a charge for the whole time absorbed in testing at the rate of 5s. per hour.

City and South London Railway. — The contract for the construction of the extension of the above electric railway has been placed with Messrs. John Mowlem and Co. The new lines will join the old portion on the south side of the Thames, and will run through to Moorgate-street, with two intermediate stations. The electric locomotives which have been so successful in constructing the Waterloo and City will also be used in this new work for hauling out the spoil.

Brussels Exhibition.—The secretary of the British Commission (Mr. J. Dredge) has issued a circular asking that all intending exhibitors should communicate with him at 35, Bedford-street, Strand, W.C., at once. Applications for space will be taken in order of date, and good positions cannot be promised after December 21. The charge is 5s. per square foot occupied. Full particulars as to transport, customs, etc., can be obtained on application to Mr. Dredge.

High Wycombe Electricity Supply Company, Limited.—This Company has been registered with a capital of £10,000 in £1 shares, to carry on in the borough of High Wycombe, Bucks, the business of an electric lighting and power company in all its branches; to enter into an agreement with the mayor, aldermen, and burgesses of the said borough, and to take over and exercise the lighting powers conferred by the Electric Lighting Orders Confirmation (No. 1) Act, 1894.

Rotherhithe.—The General Purposes Committee reported at the Vestry meeting that they had adjourned the consideration of the letter from Mr. S. Morse on behalf of the County of London and Brush Provincial Electric Lighting Company, Limited, and asked for the formal consent of the Vestry to their application to the Board of Trade for a provisional order to supply electric light in Rotherhithe. The committee desired to arrange an interview with the manager of the company.

Thornaby.—A special meeting of the Town Council has been held to consider an application from the tramways company for the reconstruction and extension of the tramways in the borough, and their working by electric traction. After some discussion it was agreed to consent to the application, subject to terms and conditions to be afterwards agreed upon, and providing the North Riding County Council consented to the laying of the lines down to Middlesbrough on the main road.

Bo'ness.—A deputation of shippers and traders has waited upon the Harbour Board urging them to have the electric light introduced at Bo'ness Docks. Mr. Conacher, general manager of the North British Railway Company, asked if the dock contractors would be prepared to consider a rearrangement of rates if the electric light were introduced. Mr. Welsh, representing Messrs. Denholm and Co., replied in the affirmative. After the deputation withdrew, it was agreed that a trial should first of all be made of incandescent-gas burners.

Leeds.—It is stated that the conference arranged to take place on Sunday next between the Yorkshire representatives of the linesmen in the employ of the National Telephone Company has been extended to all districts, it having been found that the proposals submitted to Mr. Smith, of Leeds, by Mr. Chambers, the provincial manager to the company, affected the men outside Yorkshire as closely as it concerned those within the county. Consequently the secretary of the local branch of the union has circularised the whole of the districts interested.

Rishton —In the minutes that were read at the District Council meeting it was stated that in committee some discussion had taken place as to electric communication in case of fire, and ultimately it had been resolved that a box with such connection, and with lever to the same, be placed on the footpath by Mr. Hanson's mill to work an alarm whistle at the mill, and that it be left to the subcommittee to make the arrangement. The minutes were confirmed, with the exception of the one referring to electric communication at Mr. Hanson's mill, which was referred back.

Worcester.—At the City Council meeting it was decided to instruct the engineer to fill up the spaces between the spokes of the pulley wheels of the electric motors with wood in two layers with felt between, and to substitute rubber for metal valves, at an estimated cost of £50, in order to stop the noise from the electric motors. The Electric Lighting Committee has been constituted as follows: the Mayor, the Chamberlain; Aldermen Williamson, Ernest Day, Holland, and Allsopp; Messrs. Joseph Cock, W. Caldicott, H. Day, Millington, Parker, Kay, Cook, and Rushton.

Waterloo and City Railway.—The constructional work on this line is being rapidly pushed forward by the contractors, John Mowlem and Co. We understand that one of the tunnels at Waterloo has now reached the surface, and that the other will soon see daylight. At the Queen Victoria-street end of the line a large single tube, 23ft. diameter, is being constructed to contain the siding, which has in this case to be placed some distance before the station. We understand that specifications for the electric locomotives and for the necessary generating plant will be issued to a few selected firms this week.

Wakefield.—The Corporation are offering to supply electricity to the Guardians of the union at a charge of 6d. per unit, with a rebate of 2d. per unit for all consumption beyond an average of two hours' use per day of the standard consumption as determined by the rebate indicator, with an undertaking that the annual payments shall not exceed the sum of £750 for the first two years. The Electric Lighting Committee has been appointed as follows: the Mayor; Aldermen Chapman and Sherwood; Councillors Atkinson, Bolton, Cradock, Fallas, J. W. Harrison, J. Nicholson, W. Rhodes, W. H. Smith, and Wigham.

Telegraph Wire.—The value of the export trade of this country in telegraph wire and apparatus connected therewith during October has been returned at no less than £162,054, as against £76,273 in the preceding month and only £39,769 in October last year. Although there is now no probability of the year's total

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reaching that recorded in 1894, yet it will show a satisfactory increase over last year, the aggregate exports during the 10 months ending with October having amounted to £699,905, as compared with £423,206 in the corresponding period of last year, and £1,326,856 in the first 10 months of 1894.

Leigh (Lancs).—A notice has been posted in the principal thoroughfares stating that application is intended to be made to the Board of Trade in the ensuing session under the provisions of the Tramways Act (1870) for a provisional order to authorise the construction of tramways in the urban district of Atherton, the urban district of Leigh, and the rural parish of Lowton. The publication has aroused much interest, inasmuch as the committee appointed a fortnight ago by the District Council to consider the advisability of the Council themselves acquiring the powers to construct tramways have not yet issued their report.

Brighton.—The Lighting Committee reported at the Town Council meeting that they had instructed the town clerk to insure the property up to Christmas next at premiums at the rate of 7s. 6d. per cent. per annum for the buildings and contents (excluding the dynamos), and 21s. per annum for the dynamos. These minutes were confirmed on the motion of Councillor Galliers, who said it was the intention of the committee to go into the whole question of insurance, and bring up a report between now and Christmas. The Corporation have decided not to allow the National Telephone Company to lay their wires underground.

Cork.—At the meeting of the Guardians Mr. Coakley, C.E., submitted a report upon the lighting of the house with electricity. At present there are 574 lights in the house. In view of the new buildings proposed to be erected, he provided for 600 lights. The capital outlay would be £2,000. The working expenses would be as follows: £90 for extra coal burned, £40 for men's time, £30 for renewals of lamps, etc., and £20 for oil, waste, and sundries—total, £180 per annum. There would be no new buildings required. He proposed that a portion of the room at the back of the drying-room and boiler-house, called the mangling-room, be used for engines, dynamos, etc.

Brighton and Rottingdean Electric Railway.—The seashore railway is to be opened on Saturday by the Mayor of Brighton (Alderman Blaker), Board of Trade sanction having just been received. The company's engineer, Mr. St. George Moore, will meet the visitors on the platform at Victoria Station (Brighton line) on Saturday morning at 9 50 for the 10.5 train, and will supply the ticket for the railway journey. The car will start from Paston-place jetty at 12 o'clock, and after the journey has been made a luncheon will take place at the Madeira-road shelter hall. The arrangements are under the management of the secretary, Mr. F. J. Cully, 4, Chesham-place, Brighton.

Stockton.—The Rural District Council have had before them an application from the Middlesbrough Imperial Tramways Company for permission to reconstruct the tramlines in the Council's district, extending from Stockton borough to Norton village, and to work the cars on the electric trolley system. The proposal is to amalgamate the Middlesbrough and Stockton companies, and to carry the line from the terminus at Newport, Middlesbrough, to the terminus at Thornaby, thus making a continuous line from the Royal Exchange at Middlesbrough to Norton Green, *viâ* Thornaby and Stockton, and extending over a distance of about seven miles. The Council referred the matter to a committee for consideration.

British Blahnik Arc Light Company, Limited.—This Company has been registered, with a capital of £50,000 in £1 shares, primarily to adopt and carry into effect an agreement for the acquisition of certain letters patent, for improvements in arc lamps, and to develop and turn to account the same; and generally to carry out in all or any of their respective branches the businesses of manufacturing, dealing in, working or letting on hire arc or other electric lamps, or any apparatus, implements, or things used in connection therewith, or for the production, transmission, storage and use of electric and magnetic force, power, or current, whether under the said letters patent or otherwise. The registered office is 28, Victoria-street, S W.

Croydon.—At the meeting of the County Borough Council, the General Purposes Committee recommended that, in accordance with the provisions of Clause 7 of the conditions of the electric lighting contract, the Council do consent to the assignment of the agreement dated March 12, 1896, from the British Thomson-Houston, Limited, to the British Houston Company, Limited. The borough engineer presented a plan showing suggested lighting of Church-street and Surrey-street by arc lamps. The committee recommended that the lighting as suggested be carried out. Councillor Howard Martin asked what the cost of lighting Church-street and Surrey-street with arc lamps would be. Alderman Miller replied that it would be £85 per annum.

Central London Railway. — We understand that the leading electrical firms have been asked to tender for the electrical equipment of this railway. Considerable latitude has been left to the contractor in almost every department, but we understand that locomotives, and not motor carriages, are to be used. The number of these locomotives required to maintain the three-minute service can, of course, be reduced by an increase of speed, and hence the quantity is not rigidly specified, but will be between 30 and 40. We are very glad to note that the contracts for this work will be subject to a limited competition, and trust that the rivalry between the firms may result in the most perfect system of electric traction being used through the heart of London.

Bilbao.—The proposed tramway from Zumárraga to Zumaya is referred to in *El Noticiero Bilbaino* as an enterprise of great importance to the district, and one which will shortly be realised, to judge from the enthusiasm with which it has been taken up. According to *La Union Vascongada* the line will run from Zumárraga, along the highway through the villages of Azcoitia, Loyola, Azputia, and Cestona to Tracta, where it will be bifurcate. One branch will go to Zumaya, serving on the way some cement works, the other loop going round to Cestona. Propositions have already been made by German firms for undertaking the work. When completed this will be the third interurban electric line in Spain, the others being the Bilbao and Santurce and the Bilbao and Las Arenas lines.

Wealdstone.—At the Urban District Council meeting a letter was read from Messrs. Taylor and Field, electrical engineers, stating that the first-named had paid a visit to Wealdstone and thought it eminently suitable for a successful electric light undertaking. Owing to the increasing demand for land at Wealdstone by manufacturing firms, and the high price of gas, they thought they were justified in forming a favourable opinion of the financial future of such a concern. In conclusion, they suggested they should be allowed to survey the district and prepare an accurate report. Mr. Powell did not think they were prepared to consider the question at present. The clerk was instructed to acknowledge the receipt of the letter, and to state that the Council had at present no observations to make.

Motorcar Lectures.—A special course of four lectures on the design and construction of motors for autocars, or self-propelled carriages, will be given by Prof. Watkinson, Wh.Sc., M.I.M.E., M.I.E.E., A.I.N.A., on Thursday evenings, at eight o'clock, at the Science and Arts Buildings, 38, Bath-street, Glasgow. The lectures will be fully illustrated by wall diagrams and limelight views, and they will deal with the problems involved in the design of motors of minimum weight, and with the methods of preventing vibration in such motors. The relative merits of gas-engines, oil-engines, and steam-engines working in conjunction with water-tube boilers, will be fully discussed, and some reference will be made to other possible motors for the propulsion of carriages, cars, etc. The lectures are in connection with the Glasgow and West of Scotland Technical College.

Portsmouth.—The Corporation's electric light undertaking is proving a decided financial success, and the extensions at the works already decided on are expected to prove inadequate to the requirements of the near future. Statistics were laid before the Lighting Committee last week, from which it is estimated that the income for the year ending March 31 next will reach between £13,000 and £14 000, and that a clear profit of from £2,500 to £3,500 will remain after the payment of all charges for working, interest, and sinking fund. Directly after Christmas it is proposed to further reduce the price of the current to consumers by ½d. per unit, bringing it down to 4½d., and it is also intended to endeavour to get over any complaints as to bad lights (usually the result of defective lamps) by offering to exchange one new incandescent lamp for an old one for every 50 units consumed.

Motorcar for the Queen of Spain.—A private motor carriage has been built by Messrs. Thrupp and Maberly, of Oxford-street, for the Queen of Spain. The vehicle, which is of elegant design, is called an electric victoria. The body of the conveyance in no way differs from that of the ordinary horse victoria. Mr. Julien's patent primary batteries are used for driving power. Storing room for the energy has been found under the inside and box seats, and it is claimed by the patentee that there is sufficient to propel the carriage at the rate of 10 miles an hour for 100 hours. It is fitted with a differential gear, has a chain wheel, and is steered on a pivoted axle. The interior of the carriage, which presents a quiet but handsome appearance, is upholstered with a dark-blue morocco leather, body blue, fine lined red, whilst a panel bears the arms of Spain. The wheels are a vivid red, picked out with black.

Falmouth.—The Corporation have decided not to purchase the local gas and water works. The ratepayers were dead against it, and at the meeting the manager of the waterworks asked whether the Council had placed before the ratepayers such clear and distinct statements as showed that the purchase would without doubt result in a profit, and did members of the Council possess such experience and qualifications as made it safe to entrust them with such an enormous increase in their already onerous duties? Plymouth, with gas at 1s. 9d., was putting in electric light. Torquay, with gas not much dearer, was doing the same, and the cost was only to be £20,500 for a place five times as big as Falmouth. That sum was less than half what the Falmouth ratepayers were asked to pay. He had never heard of such blind folly. Was it not almost certain that electricity would supersede gas, and leave Falmouth in a few years with nothing for its outlay?

The Repair of the "Scotia."—At the request of Admiral Sir John Fisher, K.C.B., Controller of the Navy, the Admiral-Superintendent of Devonport Dockyard has had before him the officials of the ss. "Scotia," and informed them that the Telegraph Construction and Maintenance Company had expressed their entire satisfaction with the efficient and rapid manner in which the extensive repairs had been carried out. The compliment was much appreciated by the officials and also by the "Scotia's" working party of mechanics and labourers, to whom the expression of appreciation was subsequently conveyed. The whole of the "Scotia's" fore compartments was practically reconstructed, the material used being the specially-prepared nickel-steel plates intended for the new battleship "Ocean." In addition to the cost of labour and material the Admiralty charged the "Scotia's" owners £200 for docking and undocking the vessel and £20 a day for the use of the dock. She was in dock four weeks.

Shoreditch.—Out of 43 applications for the post of permanent resident electrical engineer to the Vestry, three names were

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selected, and when they were put to the meeting eight votes were recorded to Mr. J. H. Tonge, of Preston, engineer and manager to the National Electricty Supply Company; 17 voted for Mr. H. Coles, who has in hand stations at Swansea, Pontypool, and Aberdare; and 59 votes were given for Mr. C. N. Russell (38 years), of Highgate, chief engineer of the electric light works, Grosvenor-road. The latter has had a large all-round experience, and was appointed by the Vestry. The Lighting Committee of the same Vestry reported that they had consi ered a notice from the County of London and Brush Provincial Electric Lighting Company of their intention to apply for a provisional order under the Electric Lighting Acts in respect of a portion of Shoreditch. On the recommendation of the committee the Vestry decided to oppose the application in so far as it was an extension of the agreement already entered into with the company. Sixteen tenders for the supply of electrical materials were received and sent to the Electric Lighting Committee.

Hastings.—Mr. L. Andrews, the engineer and manager of the electric lighting company, stated, in an interview with a representative of a local paper, that they could supply an equal amount of electric light as cheaply as gas, and he thought that the Corporation ought to take the advice of an expert. Enquiries had recently been made among their consumers, and the following were the results: 51 per cent. of their customers, using between them 4,860 8-c.p. lamps, testified that they consider electricity as cheap as gas, that they have no complaints to make about their supply, and that they have no reason to regret having it installed; 8 per cent. consider it dearer than gas; 4 per cent. have complaints to make; and under 2 per cent. regret having had it installed. Nearly all complaints had been traced to the following causes: first, the use of lamps of unsuitable size; second, bad arrangements of lamps; third, continued use of old and blackened lamps. A letter in one of the newspapers strongly advocates the adoption of electric light in the churches. The South-Eastern Railway Company are about to run an American car train, consisting of first, second, and third class saloon carriages, lighted by electricity and warmed throughout with hot-water pipes, between Hastings and London.

Omagh.—A meeting of the Board of Governors of the asylum has been specially convened to consider the question of lighting the asylum with electricity, which Mr. Owens, Local Government architect, had stated could be done for £140 less money than the present lighting of gas. Colonel Buchanan moved that the proposition to substitute paraffin-oil gas instead of coal-gas be not entertained by the Board. Mr. J. Brown seconded the motion, which was passed. Colonel Buchanan moved the following resolution, which was seconded by Colonel Lowry, and passed unanimously: "That the question of the electric lighting of the institution be deferred until the Board is better informed as to its advantages, and that the clerk be directed to ascertain from the asylums in Ireland that have adopted electric lighting, and from asylums in England, of nearly the same extent as this asylum, similarly lighted, the following information: (1) the cost of electric lighting per head of population of institution; (2) the annual cost of electric lighting per head; (3) a general statement of the opinion of the several Boards on the relative merits of electric lighting, as contrasted with other modes of illumination; (4) the annual cost of supervision, and such other information as will enable the Board to come to a decision on the matter."

Reading.—Mr. Clifton Robinson, managing director of the Reading Tramways Company, has addressed a long letter to the town clerk relating to proposed alterations in the company's system. In it he advocates the advantage of electric traction by the overhead trolley system. After mentioning instances where the system has been successful he cites the company's proposals. These comprise the reduction of the gauge of the lines to 3ft. 6in., in order that double lines may be introduced in most of the streets; the extension of the King's-road line to St. Peter's-road; the extension of the present Oxford-road tramway to the "Pond House"; the construction of a tramline from the Gosbrook-lane and South-street, Caversham, junction (*viâ* Friar-street, West-street, Bridge-street, and Southampton-street), to Christ Church-road at Whitley-crescent; the construction of a tramline from the King's-road line at Duke-street, *viâ* London-street to the junction of Mount Pleasant and Southampton-street; the equipment of all the lines with the trolley system of traction; and the introduction of halfpenny workmen's fares. The whole of the lines both as reconstructed and as newly laid, would be operated electrically on the trolley system, the wires being carried on ornamental iron standards and brackets along the streets and roadways, of like design and character to those generally in use throughout the world, and as seen in successful operation at Bristol, Dublin, Leeds, and Hartlepool, and as now under construction at Birmingham and other important cities.

Sedgley.—At a special meeting of the District Council to consider the proposed amalgamation of the Staffordshire Tramways, Mr. Sellon, the electrical engineer to the British Electric Traction Company, attended and explained that the company were negotiating for the purchase of the tramways throughout that district, including those on the South Staffordshire route, the Dudley, Sedgley, and Wolverhampton route, the Dudley, Brierley Hill, and Stourbridge route, and it was proposed that the cars on the whole of the routes should be propelled by overhead electric wires. In addition, it was proposed to provide branches from the Fighting Cocks, near to Wolverhampton, to Bilston, also from Dudley to Kingswinford, from Dudley to Netherton and Cradley Heath; and it was hoped later on to provide an extension to Lower Gornal under the Light Railways Act. It was proposed to apply for a Bill to enable them to unite the whole of the tramways. It was necessary that all the gauges should be uniform, but at present that on the Dudley, Sedgley, and Wolverhampton line was wider than that of the others. In the scheme it was proposed that there should be one terminus at Five Ways, Wolverhampton. They hoped to come to an arrangement with the Dudley and Wolverhampton authorities. Cars would run every 10 minutes, and generating stations would be made at those two places. In such a big scheme it was absolutely necessary that there should be a settled agreement as it was proposed to spend nearly a million of money.

Glasgow.—At the meeting of the Tramway Committee, the chairman, Mr. Walter Paton, stated that it was the first meeting at which the members had had an opportunity of welcoming Mr. Young, the general manager, since his return from America. He assured him that they all rejoiced to see him home again, and added that if he had anything to say about his tour of inspection they would be glad to hear him. Mr. Young thanked the committee for their cordial reception, and stated that he and his engineer, Mr. Clark, had spent five weeks in the United States visiting all the cities and towns, and seeing all that was to be seen in the way of mechanical traction. He said that he had found that the cable had latterly made no progress whatever; on the contrary, a number of cable lines had been converted so as to be used for electric traction. The application of electricity for purposes of tramway traffic had made enormous strides in recent years; indeed, throughout the States it was the only form of traction which was being universally adopted. Mr. Young further stated that he hoped to be able to present his report in the course of a fortnight. In the meantime he desired to say, generally, that in his opinion the overhead trolley system seemed to be much preferable to horse haulage. He had made special enquiries in regard to the danger to be apprehended from falling wires. As the result he had not been able to find that anyone had been injured from this. The mayors of some of the larger cities had stated that they regarded the trolley system as being freer from accident than horse traction.

Electric Omnibuses.—A private run of the first electrical omnibus of the London Electrical Omnibus Company, Limited, took place last week. It was discovered that the wires of the car had been tampered with, and Mr. Radcliffe Ward, the inventor of the system, stated that during 24 hours he had found the wires had been tampered with on three occasions, and the only conclusion he could arrive at was that it had been done maliciously. Mr. Ward, however, thought that he could run at slow speed, but after journeying from the Hotel Victoria to Whitehall it was considered that it would be better to postpone the trip until a later hour. It was, however, afterwards discovered that the damage done had been of such great extent that it would take some hours to put matters right. The car holds 26 persons, 12 inside and 14 outside. The wheels are small, made of wood, with iron tyres, and the car itself is on a bed of pneumatic cushions. The weight of the 'bus, irrespective of the cells, etc., is three tons, but there are 72 cells, each of which weighs 26lb., against 56lb., the weight of the cells in the omnibus constructed by Mr. Ward some years ago, in which he states he has travelled no less than 500 miles throughout the Metropolis at the average speed of seven miles per hour. The present omnibus, it is stated, is capable of running seven hours at the rate of five miles an hour, the maximum speed allowed by the Local Government Board regulations for cars of that weight. The company are offering three prizes to the amount of £150 for improved original and artistic designs for the shape and form of body for omnibuses and cabs suitable for the company's business.

Edinburgh.—Messrs. Cameron and Mackenzie gave notice of motion at the last meeting of the Town Council that it be remitted to the Lord Provost's Committee to consider the advisability of giving consideration to the more recent mechanical motors in view of the tramway extension to Portobello, and report. One of the largest installations of the electric light which has yet been introduced into the city is that which has just been fitted up in the General Post Office by Messrs. W. Barton and Sons, Forrest-road, Edinburgh. The installation includes 36 10 ampere arc lamps and 540 incandescent lamps. The arc lamps, which are of the Brockie-Pell double-carbon type, are of 2 000 c.p. each, and are connected four in series on a 230-volt circuit. The whole of the building has been lighted and wired for electric energy supplied at 460 volts, and provision has been made at the same time for any future extension of the premises. The switchboard, the largest connected to the Corporation mains in the city, is placed in the basement. It is built of six slabs of enamelled slate, 1¼in. thick, each separated by insulated fillets of vulcanised fibre. On this are mounted two ammeters and a voltmeter for indicating the quantity and pressure of the current, and 12 triple pole switches and fuses, each carrying 50 amperes, which control the main circuits. Eight sub-main switchboards are placed in the various sections of the building. A novel feature of the installation is the lighting of the public telephone-cabinets by an automatic switch concealed in the seat provided for the speaker at the instrument, by means of which the light is turned on when the telephone is being used.

Minster.—Mr. West, on behalf of the Lighting Committee, laid before the Guardians at their last meeting the result of the investigations made by that committee for the purpose of ascertaining the practicability of adopting a system of electric lighting at the workhouse, instead of the present gas lighting. The information that came nearest their requirements was Sunnyside Asylum, Scotland, where they had 430 lights of 16 c.p. The cost there for installation was £1,800, with an annual cost of £244, and allowing 10 per cent. for depreciation. That was very low and very favour-

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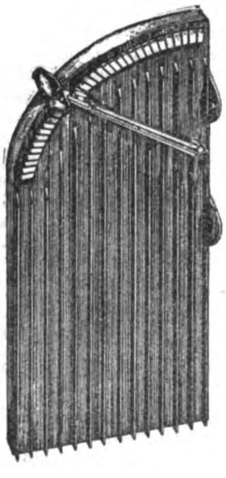
able to its adoption; but it should be pointed out that at Sunnyside coal was very cheap, the cost being only £41 per annum. Of course, coal would cost much more at Minster. As it was the wish of the committee that the question should be settled by the Board, he thought it only right that they should know what information had come to hand on the other side. They had received a letter, which was not exactly sought, from Mr. Valon, of Ramsgate, in which he recommended the adoption of incandescent burners, which they would find cheaper and more effective than electric light. Mr. West proceeded to give a list of institutions where electric light was in use and where the cost of gas was as low as 1s. 4½d. per 1,000. So far as the enquiries of the committee went, it seemed to them that the electric light could be installed at the workhouse at £1,500 or £2,000, and that the annual cost would come out at less than they were now paying for gas. On that data they asked the Board to decide the question. Ultimately it was decided to consider the question that day fortnight.

Electric Tramways in India.—The *Pioneer* of India says a point in the recent Government telegraph report which should attract notice is the reference to electric tramways in India. Calcutta is likely to have electric motive power on its tramlines sooner or later, and the experience gained down south should not be ignored. The tramway in Madras, the first of its kind in India, consists of three sections, one being worked on the conduit system, and the others on the overhead trolley plan. The conduits were tried first, but the difficulty of keeping them free from road refuse and water was found to be very great. Neither system, it appears, has materially disturbed the departmental telegraph or telephone circuits, nor was the testing apparatus affected prejudicially. But the telegraph companies working the traffic with the Farther East, and also the Oriental Telegraph Company, claimed protection from serious interference with their wires, due to the high currents used on the tramways. It was found that the interference was very real, and the tramway company had to pay for diversions of the telephone wires, which were re-aligned so as to escape the areas of disturbance. The Eastern Extension Cable Company also recovered the cost of relaying their cables in a pipe, which affords sufficient protection. The tramway company were not careful enough at first in putting up their overhead lines for the trolley system, and some of the Government telegraph wires were fixed at street crossings. This was a small matter, and the trouble was easily overcome. The Calcutta Municipality will doubtless see that all precautions are taken to safeguard the telegraph and telephone wires if electric traction in the tramways is introduced.

Catalogue.—We have received a catalogue of the iron-clad rheostats, stage-dimmers, motor-starting rheostats, etc., which are sold by the Stewart Electrical Syndicate, Limited, 103, New Oxford-street, London, W.C. The accompanying illustration is one of the theatre-dimmers. These are particularly designed for the limited space in the wings of a theatre, taking up no more room than the switch alone of the old-style dimmers. The throw of the switch is so proportioned that (where several dimmers are installed) any or all of the dimmers may be thrown in simultaneously. Large dimmers are made up of two or more plates connected in series, the terminals of the steps being brought to the contacts on the face-plate. They are in use at the Gaiety, London, and in the new theatre at Cork. Messrs. Stewart also send us a catalogue of the Stewart enclosed arc direct-current lamps. With these lamps carbons are furnished, after the first trimming, of only one standard length. This is due to the fact that the unconsumed portion of the upper carbon serves for the lower, after the first trimming, with a consequent saving of expense. Current consumption on the Stewart lamp is 4¾ amperes for best results.



Cardiff. — The Cardiff Tramways Company, Limited, are applying to Parliament for a provisional order authorising them to make certain extensions within the borough of Cardiff, and to double several portions of the existing lines. It is proposed to make a single line, with four passing-places, from a point north-east of Wordsworth-street, thence along the new street in course of construction between Newport-road and Clifton-street, and along Broadway to the present terminus near the Royal Oak Hotel. Another short line will connect the Newport-road and Grangetown systems by a tramway passing through Grove-road and Moira-place. It is proposed to make a double line, except for short distances, along Pearl-street and Splott-road to Moorland-road, East Moors, and another double line through Castle-road, Albany-road, and Wellfield-road, terminating at Wellfield-road at its junction with Ninian-road. A double line from Cowbridge-road, through Neville-street, Clare-street, Clare-road, Corporation-road, and terminating at Harrowby-street, at the Docks, is also contemplated, while the single line now terminating at Clive-road will be extended to Canton Park. Power is also sought to double several lengths of line in Cowbridge-road, St. Mary-street, Working-street, Bute-road, Newport-road, Custom House-street, and on the Cathays section. One of the clauses states that it is intended to employ electrical power, either by the overhead system or otherwise. At a meeting of the General Purposes Committee, communications were read from Messrs. Vachell and Co., solicitors, as to the proposed electric tramway between Cardiff and Penarth, asking for sanction of the Corporation to a provisional order for it. It was decided to send the letters to the Parliamentary Committee for consideration and report. Alderman Carey has been appointed chairman of the Lighting and Electrical Committee, with the Deputy-Mayor (Mr. Morgan Morgan) as vice-chairman.

Motorcart Competitions and Races.—It will be remembered that the proprietors of the *Engineer* offered five prizes ranging from 350 guineas to 100 guineas for mechanical road carriages, but that the competition was postponed to await the passing of the Light Locomotives Act. The rules for the competition have now been republished. The time of entry is next March, the preliminary trials will be at the Crystal Palace, and the final race about the end of May. Mr. C. Harrington Moore, hon. secretary to the Motor Car Club, writes from 40, Holborn-viaduct: "I am directed by Mr. Harry J. Lawson, the president, and by the committee of the Motor Car Club, to notify to you that it is the intention of the club to hold a great motorcar competition some time in May next year. The tests will be given on the point of design of the motorcar, consumption and cost of fuel, and other points, but the principal point will be speed, which we are of opinion affords the most satisfactory test as to the excellence of construction of a mechanical vehicle. It is proposed to offer for competition £2,000 in prizes. Notice of this competition is given thus early in order to enable English manufacturers to be prepared with their productions in good time. If sufficient entries are received the committee will confine the competition to British-made motor vehicles. In order to carry out this competition satisfactorily, the committee will require special ground within easy access of London, and containing at least a full, level, and straight mile. A special prize will be offered to the first mechanically-propelled vehicle which accomplishes a mile in a minute. Owners of racecourses and other large enclosed places are invited to communicate with me if they are prepared to co-operate in providing the necessary course. All communications on this subject should be addressed to me at the above address." Mr. Harry Lawson has, on behalf of the British Motor Syndicate, made a firm and substantial offer to the directors of the Epsom Grand Stand Association for the purpose of obtaining from time to time the use of the Epsom race track for motorcar races. A special feature will, in the event of terms being arranged, be made of a grand motor Derby at some suitable date in the month of May. It is stated that the scheme meets with serious opposition in some quarters.

Bradford.—Mr. A. H. Gibbings, the electrical engineer to the Corporation, has prepared a report for the Gas and Electricity Committee with reference to the proposal for the adoption of electricity as the motive power for tramways to Great Horton and to Bolton. The report shows that the Bolton line would have a length of a mile and 1,540 yards, while the Horton line would be two miles 1,500 yards in length. Mr. Gibbings deals exhaustively with the probable cost of working, the estimate being based to a certain extent upon the experiment tried some years ago with the overhead electric traction between Forster-square and the Grammar School. He points out that the Corporation possess many advantages now which they did not possess at that time. Amongst them are a working pressure of 500 volts instead of 300, the present central lighting station having sufficient power to drive a 10 minutes' service of three times the number of tramcars now running on all the systems in Bradford. While supplying current from the electricity works, the working of the tramways could, if desired, be entrusted to a private company; but it would be more profitable for the Corporation to themselves manage the whole of the working. The total cost of working a 15 minutes' service on the Horton route is estimated at 9·43d. per mile per car, and for a 10 minutes' service at 8·25d. The total capital cost for the Horton section is placed at £18,660, of which £2,000 is for sheds and offices, £1,600 for four cars at £400 each, and £15,060 for rails, cables, paving, etc. The length of the Bolton section being considerably less, the cost per mile per car is calculated to come out at 25 per cent. more than on the Horton section. If the two sections were worked conjointly the cost would probably be reduced to 8d. per mile per car. The additional capital required for a 10 minutes' service, as against a 15 minutes' service, would be small compared with the material reduction in the mileage cost. As for the effect on the electricity works a charge of 1½d. per unit would yield a profit of ½d. per unit, or an income of £277. 1s. 8d. on a sale of 133,000 units in the year, which would be gained without further expenditure on the works. The application of electricity to tramway traction, it is stated, opens up the possibility of a great reduction in the price charged for electricity for illumination purposes. The route proposed for the Horton tramway is by Morley-street, Easby-road, All Saints'-road, and Great Horton-road to the borough boundary at Horton Bank Top, with a loop line from the top of Easby-road, along Laisteridge-lane and Park-avenue to Great Horton-road. The report is decidedly favourable to the adoption of electricity for the proposed new sections of tramway.

Hampstead.—The Lighting Committee reported at the last meeting of the Vestry that they had given instruction for the charge of 10s. 6d. for each inspection of consumers' premises after the first test and inspection to be duly enforced. They had approved of the variations in the contract for the additions to the electric lighting station as set out in the letter from the architect dated October 30. They had instructed the vestry clerk to resist the claim, amounting to £11. 16s. 1d., made by Messrs. B. Dellagana and Co., Limited, for loss of time and delay of work by a failure of the supply of electric current to their branch in

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Gayton-road, which they alleged to have been caused by a breakdown on the Vestry's main. They recommended that a low-tension main for the supply of electric current to Christ Church, Hampstead-square, be laid down at an estimated cost of £52. The report was adopted. Mr. Newton referred to the protest which appeared in a local paper from residents in Heath-street, and asked if any steps had been taken to light the whole of that thoroughfare, instead of a portion only, by electricity. The Chairman said that the Vestry had only recently decided upon a scheme for lighting a portion of Heath-street, with High-street and Haverstock-hill. It was unreasonable to expect the Vestry to entertain further projects before they saw if that already decided upon answered. Mr. Stone remarked that the residents of Heath-street could make application in the usual way. Mr. Jones asked if the Lighting Committee had considered whether anything could be done to utilise the dust destructor in the generation of electricity, as was done in some other places. Mr. Reed, chairman of the committee, said that the subject had been considered. He believed that the utilisation of dust destructors in this way was not altogether a success. A long and somewhat heated discussion took place on the following resolution, which was moved by Mr. McMillan, and seconded by Mr. Chandler: "That full details of the scheme for the extension of street electric lighting authorised at the last meeting of the Vestry be prepared by the Lighting Committee, and be submitted to the Vestry for approval." It was contended by several members that sufficient details had been furnished, but the motion was eventually carried, after the words "further particulars" had been substituted for "full details." Mr. McMillan intimated that he reserved the right, if the details furnished did not satisfy him, to call a special meeting to consider the subject of rescinding the motion passed at the previous meeting to light High-street, Heath-street (south of High-street), Rosslyn-hill, and Haverstock-hill with 28 arc lamps, at the estimated cost of £1,625, such sum including the necessary lamps, switches, cut-outs, lamp-posts, cable, engine, dynamo, with all necessary foundations and connections.

Hammersmith.—At a meeting of the London County Council the Finance Committee reported as follows: "We have considered an application from the Vestry of Hammersmith for the loan of £41,048 for electric lighting purposes. The Vestry purchased in July, 1895, the freehold of 57 Fulham Palace-road, upon which they are now erecting a boiler-house, engine house, chimney shaft, and other buildings necessary for the installation of the electric light, and they have to provide the necessary electric lighting plant. The Council's architect reports that he has examined the plans, specifications, and bills of quantities for the proposed buildings, and considers the estimated cost, £8,483. 4s. 1d., to be fair and reasonable, and the engineer reports that the cost of boilers, engines, dynamos, switchboards, rectifiers, piping, mains, arc lamp posts, lamps, and fittings is estimated at £30,431. 17s. 5d., in respect of which he can recommend at present a sum of £30,022 as reasonable for certain of the proposed plant and works. The Vestry have found it desirable to increase the area of the station, and have purchased an additional piece of ground adjoining that already acquired, at a cost of £307. 11s. 9d., and have also expended a sum of £100 beyond the £7,000 borrowed to purchase the original site, and this expenditure the valuer reports reasonable. We have eliminated from the amount (£41,046) applied for the sum of £2,111, a large part of which is for contingencies which may not arise, and which, if required, may be made the subject of a further advance. The present loan should therefore be limited to £38 935. We recommend: (*a*) That, subject to the Council hereafter giving its written consent under seal to the borrowing, and subject to all necessary consents and evidence being furnished to the satisfaction of the solicitor of the Council, the application of the Vestry of Hammersmith for a loan of £41,046 towards defraying the cost of an electric light installation in that parish, be granted to the extent of £38,935, on condition that the loan be taken up at once, interest being charged at the rate of £2. 17s. 6d. per cent. per annum, payable quarterly, on January 31, April 30, July 31, and October 31, in each year, and the principal being repaid by equal annual instalments on each 31st October, within a period of 42 years; that it be referred to the solicitor to take the necessary measures for completing the loan, and that the amount be advanced out of the consolidated loans fund. (*b*) That it be notified to the Vestry of Hammersmith that, as they have elected to spread the whole of the initial cost of the electric light installation over 42 years, the Council will decline to give its sanction to the raising of any loan to replace any of the plant and machinery which may be necessary during the currency of the loan, and will expect the Vestry to provide for all renewals required during that period out of a sinking fund to be provided or from maintenance account." This was agreed to.

Leith.—A statutory and special meeting of the Town Council has been held to consider the minute of a special committee on electric lighting. The minute stated that the streets to be included in the area of supply in which the undertakers—*i.e.*, the Town Council—propose that the electric lines or distributing mains for the purposes of general supply shall be laid down within a period to be specified in the order were as follows: Great Junction-street, North Junction-street, Portland-place, from No. 1 to No. 14 thereof; Mill-lane, Giles-street, from Sheriff-brae to Henderson-street; Henderson-street, from Giles-street to Tolbooth-wynd, at Shore; Tolbooth-wynd, Kirkgate, Charlotte-street, from Kirkgate to Constitution-street; Constitution-street, from Bernard-street to Duke-street; Bernard-street, Duke-street, Morton-street, Links, from Morton-street to Leith Academy; Leith-walk, from Duke-street to Pilrig-street, at burgh boundary. On the minute coming up for approval, Bailie Manclark moved its adoption. Councillor Kinnaird seconded. He thought the sooner the electric light was in Leith the better. He had spoken to several large shopkeepers who were simply waiting for it to be put in. He saw that Edinburgh, Glasgow, London, and other places commenced on a small scale, and he thought Leith might do the same thing. Bailie Manclark, in reply to Bailie Robertson, said the proposed streets were simply a trial. They had taken a reasonable area just now—the business part of the town—and afterwards the whole burgh might be included. In everyone of the streets proposed some people were going to take the light. Councillor Baxter said that at one time he was in favour of the electric light, provided that it could be had as cheaply, or nearly as cheaply, as in Edinburgh. From every source, however, he was led to believe that it was utterly impossible to provide the light for anything like the cost in Edinburgh. The Council was now asked to rush into this expenditure, estimated at £25,000, to light districts where it was a sheer impossibility that it could be taken up in such large quantities as to become remunerative. He asked if it was at all likely that shopkeepers would take up the light in certain of the streets specified. They had no guarantee that shopkeepers in certain streets would continue to take the light after it was in. Taking things all in all, there was a likelihood that they might get their fingers severely burnt on the question. They should delay, at all events, for a year, and allow the new members to make enquiry. They should go round and find out how many people were likely to take up the light. If Edinburgh were sincere in their amalgamation proposals, Edinburgh ought to offer them an installation of the light from their system when they asked for it. That was the kind of amalgamation he intended to go in for—amalgamation on every point that was likely to be of great advantage to Leith. He moved a direct negative to that minute. Mr. M'Kelvie seconded, and said he was convinced that they were not in a position to make the light a financial success. Mr. Mackie said there was no use in approaching Edinburgh in the sense that Mr. Baxter referred to at the close of his remarks, as they were not likely to meet with success. Bailie Gibson said that ultimately electric lighting was bound to be a paying concern in the burgh. The Provost said they had shown Edinburgh examples in adopting things that were to the advantage of the ratepayers. They did not lag behind any town. After further consideration the division was taken, when 13 voted for the approval of the minute and three against. At a conference between the Tramways Committee of the Corporation and the directors of the Edinburgh Street Tramways Company it was stated that the directors understood that the Corporation were more in favour of other motive power than cables, and that they had intended to bring for experiment one of the oil motorcars, but that difficulties had come in the way. The directors were satisfied that cabling was not in any sense the best possible means of dealing with the traffic in Leith. They had every hope that electricity would be much more satisfactory, but whatever suggestions were made by the Town Council would be fully considered. The feeling of the Council generally was that electricity by the overhead system would be best for Leith, and would admit of reasonable possibilities of the whole line being worked in that way if the directors or their engineers could guarantee that the Edinburgh cars could be made to run on the Leith lines by electricity. The directors promised to get the best possible advice as to such a scheme. It was agreed, before going further, to wait for the report from the tramway company as to the overhead electric system.

PROVISIONAL PATENTS, 1896.

NOVEMBER 16.

25729. Improvements in electric meters. Emile Batault, 21, Ely-place, Holborn-circus, London.

25786. Improvements in or relating to the strengthening of electric currents. Moriz Reichsritter von Leon, 322, High Holborn, London.

25798. Improvements in the manufacture or production of chlorates and hypochlorites of potassium and sodium by electrolysis and in apparatus therefor. James Greenwood, 4, South street, Finsbury, London.

25799. Improvements in the construction of electrodes for accumulators. Friedrich Wilhelm Schneider, 18, Buckingham-street, Strand, London. (Complete specification.)

25804. Improvements in the electrolytic production of zinc and alkalies. Dieffenbach, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

NOVEMBER 17.

25844. Means for storing up the electricity generated by the application of the brakes to the wheels of motorcars or locomotives. Martin Ellis Thomas, William Fillmore Toops, James Monroe Hulen, Henry Lee Hendrick, Edward la rue Hendrick, and Robert Walter Hendrick, 89, Chancery-lane, London. (Complete specification.)

25895. Improvements in electric arc lamps. Alexander Bewicke Blackburn and George William Fairall, 47, Lincoln's-inn-fields, London.

25903. Improvements in controlling electric arcs. The British Thomson-Houston Company, Limited, 70, Chancery-lane, London. (Elihu Thomson, United States.) (Complete specification.)

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25896. **Improved electric insulators** Charles William Six, 70, Palace-chambers Westminster, London.

25904. **Improvements in regulating polyphase circuits.** The British Thomson - Houston Company, Limited 70, Chancery-lane, London. (Albert H. Armstrong United States.) (Complete specification)

25906. **Improvements in contact systems for electric traction.** William Phillips Thompson, 6, Lord street, Liverpool. (Thomas Inman Coppin, South Africa.)

25943 **Improvements in or connected with portable electrical apparatus** J. Mayer, 40, Chancery - lane, London. (Complete specification.)

25948. **Improvements in electric accumulators and in the manner of their use.** Clovis Pierre François Clerc and Adolphe Georges Pingault, 111, Hatton-garden, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103 August 8, 1893 being date of application in Belgium.) (Complete specification.)

NOVEMBER 18.

25965. **Improvements in the electro-deposition of metals** John Boultbee Brooks and John Holt, 24, Temple-row, Birmingham.

25989. **Improvements in generating plant for producing alternately or simultaneously continuous and alternating currents of electricity,** George Adams, 55, Victoria-street Westminster, London.

26000. **Combination of electrolysis and Rontgen rays.** David Greville, 68, Jubilee-drive, Kensington, Liverpool

26003. **Improvements in electrically-propelled velocipedes, carriages, and other like vehicles.** Charles Adams-Randall, 63, Chancery-lane, London.

26009. **Improvements in and relating to electric light and current regulating switches** William Welford and Louis Héndlé Lynette avenue, Clapham Common, London.

26053. **Improvements in electric controllers.** William Henry Morgan, 18, Buckingham-street, Strand, London. (Complete specification.)

26059. **Improvements in electrodes.** Charles Cunningham Connor, 191, Fleet-street, London.

26061. **Improvements in electric clocks.** Hubert Henry Grenfell, 45 Southampton-buildings, Chancery-lane, London. (La Société Anonyme La Precision, Belgium.)

26069. **New or improved electrical lighting or igniting apparatus** Ernest Oldenburgh, 115, Cannon-street, London. (Complete specification.)

NOVEMBER 19.

26099. **Improvements in and connected with means for electrically lighting railway carriages.** Emil Dick, 4, Corporation-street, Manchester.

26100. **Improvements in and in connection with the manufacture of electrodes for secondary electric batteries.** Henry Leitner, 1, Broad-street-buildings, London. (Complete specification.)

26144. **An improved electric switch especially intended for controlling and regulating the speed of electric motors** Ernest Francis Moy, 433, Strand, London.

26155. **Improvod means for jointing electrical conductors.** Robert Cattley Jackson, 70, Chancery-lane London.

26164. **Improvements in electrodes for secondary or storage batteries.** Gerschon Joesel Epstein 47, Lincoln's-inn-fields, London.

NOVEMBER 20.

26200. **Improvements in electrically lighting incandescent and other gas burners.** Frederick Richard Boardman, 238, Tottenham Court-road, London.

26246. **Improvements in trolley mechanism for electric tramways.** Cie. de l'Industrie Electrique, 45 Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, May 16, 1896, being date of application in Switzerland)

26249. **Improvements in electrical heating apparatus.** Herbert John Dowsing, 28, Southampton-buildings, Chancery-lane, London.

26267. **Improvements in enamelling processes for electric heating apparatus.** Rookes Evelyn Bell Crompton and Edmund John Fox, 55, Chancery-lane, London.

26275 **An improvement in or relating to boxes for electric conduit wiring.** Charles Newton Russell, 166, Fleet-street, London.

26278. **Improvements in or relating to electric switches and controlling devices.** Joseph Slater Lewis, 322, High Holborn, London.

26281. **Improvements in or relating to the manufacture of metal sheets or strips by electro-deposition.** Karel Klic, 6, Lord-street, Liverpool. (Complete specification.)

26303. **Improvements in dynamo-electric machines.** William Lloyd Wise, 46, Lincoln's-inn fields, London. (Aktiebolaget de Lavals Angturbin, Sweden)

NOVEMBER 21.

26307. **Improvements in electric indicators** Frederick Charles Allsop, 97, Queen Victoria-street, London.

26313. **An automatic regulator for alternating or rectified currents.** Walter Langdon-Davies, 16, Red Lion-street, Clerkenwell, London.

26375 **Improvements in electrical trams and railways.** Theodor Petersen and William Douglas Reid, 24, Southampton-buildings, Chancery-lane, London.

26390. **A new motor device applicable to electrical apparatus.** William Jandus and John Brunswick Barton, 18, Southampton buildings Chancery-lane, London.

26419 **An improved primary battery.** Marie François Xavier Fuchs, 45, Southampton - buildings, Chancery - lane, London.

SPECIFICATIONS PUBLISHED.

1895.

20288. **Closed-conduit system of electric railways.** Hull.

20529 **Distribution of electricity over electric railways.** Cattori.

20542 **Apparatus for the electrolytic decomposition of liquids** Bell and Bell.

20600. **Electric incandescent or glow lamps.** Bott.

21357. **Telegraphy and telephony and electric relays for use therewith** Mercadier and Pierquin.

21657. **Submarine telegraph cables.** Crawford.

22717. **Telephonic apparatus.** Kotyra and Milde.

23864. **Telegraphic receivers, especially applicable for submarine telegraphy.** Piedfort.

1896.

533 **Automatic remontoir apparatus for Hughes's telegraph apparatus.** Siemens Bros. and Co., Limited. (Siemens and Halske)

1480. **Electric gas-lighting apparatus.** Brewer. (Farquharson and Root.)

4179. **Electric road vehicles actuated by electricity.** Machin.

8353. **Construction or arrangement of generator of electricity.** Aizr.

14020 **Electrically-propelled velocipedes** Clerc and Pingault.

16418. **Method of and means for automatically regulating arc lamps and other electrical apparatus** De Graaff.

19757. **The connection of constant-current dynamos to electric lamp circuits.** Lake (Black.)

20095. **Controlling and reversing switch for electromotors and similar uses.** Royce and Claremont.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	7½-8
Brush Company, Ordinary	3	¾-1¼
—— Non. Cum., 6 per cent. Pref.	2	1-1½
—— 4½ per cent. Debenture Stock	100	110-113
Central London Railway, Ordinary	10	9¾-10¼
——	2	4-4½
Charing Cross and Strand	5	9½-10
Chelsea Electricity Company	5	7¾-8¼
—— 4½ per cent. Debentures	100	114-117
City of London, Ordinary	10	15½-16½
—— 6 per cent. Cumulative Pref.	10	16½-17½
—— 5 per cent. Debenture Stock	100	130-135
City and South London Railway, Consolidated Ordinary	100	52-54
—— 4 per cent. Debenture Stock	100	136-138
—— 5 per cent. Pref. Shares	10	15-15½
County of London and Brush Provincial Co., Ordinary	10	8-9
—— 6 per cent. Cum. Pref.	10	13¾-14½
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1¾-2¼
Edison and Swan United Ordinary	3	1¾-2¼
—— 4½ per cent. Debentures	100	103-106
Electric Construction, Limited	2	1¼-1¾
—— 7 per cent. Cumulative Pref.	2	2½-3
Elmore's Copper Depositing	2	¼-¾
Elmore's Wire Company	2	¼-½
W. T. Henley's Telegraph Works, Ordinary	10	17-18
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	109-114
House-to-House Company, Ordinary	5	3¾-4¼
—— 7 per cent. Preference	5	8¾-9¼
India Rubber and Gutta Percha Works	10	20½-21½
—— 4½ per cent. Debentures	100	105-108
Kensington and Knightsbridge Ordinary	5	9½-10
—— 6 per cent. Pref.	5	8¼-8¾
Liverpool Electric Supply, Ordinary	5	8-8½
Liverpool Overhead Railway	10	18¾-18¼
—— 5 per cent. Pref.	10	17½-17⅞
—— 4 per cent. Mortgage Debentures of £100	100	112½-114½
London Electric Supply	5	⅞-1⅛
Metropolitan Electric Supply	10	13-14
—— 4½ per cent. First Mortgage Debenture Stock	100	121-124
National Telephone, Ordinary	5	7-7½
—— 6 per cent. Cum. First Pref.	10	17-19
—— 6 per cent. Cum. Second Pref.	10	17-19
—— 5 per cent. Non. Cum. Third Pref.	5	6⅜-6⅝
—— 3½ per cent. Deb. Stock	100	105-108
Notting Hill Company	10	9½-10½
Oriental, Limited, £1 shares	1	1¾-2
—— £5 Shares	5	8¾-9¼
—— £4½ shares	4½	7¾-8¼
Oriental Telephone and Electric Company	1	½-¾
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	103-105
Southampton Electric Company	5	4¾-5¼
St. James's and Pall Mall, Ordinary	5	12-13
—— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	39-42
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	—	7¾-8¼
Westminster Electric Supply, Ordinary	5	10½-11½
Yorkshire House-to-House	—	7½-8

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NOTES.

Acetylene Safety Rules.—Regulations have been drawn up for the manufacture, storage, and use of acetylene in Paris, and will probably shortly come into force.

The Pacific Cable Conference. — The British, Canadian, and Australasian delegates to the Pacific Cable Conference have been having quite a number of meetings, but what they are doing remains a mystery, since the proceedings are strictly private. It is supposed that they are "taking evidence."

Northern Electrical Engineers.—The Northern Society of Electrical Engineers have their annual general meeting at the Palatine Hotel, Hunt's Bank, Manchester, on Monday, December 7, at 7.30 p.m. This will be followed by an ordinary meeting, at which a paper on "The Manufacture of Alkali and Bleach by Chemical and Electrolytic Methods" will be read by Mr. Bertram Blount, of London

Continuous Rails.—It is stated that at present there are in use in America from 150 to 200 miles of street railway track the joints of which have been all welded, either by the electrical or the "cast-welding" system, so that the rails are actually continuous. As to the success of this system, the testimony is rather conflicting; but it is obvious that the difficulties to be encountered are serious.

Metric System.—Lord Cromer does not see his way—according to a communication from the Foreign Office to the New Decimal Association—to make the metric system compulsory in Egypt, though it is practically already in use for most purposes of foreign trade and manufactures, and the entire supersession of the old native weights is probably merely a matter of time. Egypt has already a decimal coinage.

Remuneration.—Across the Atlantic, *Electricity* (New York) has been mocking at our Worcester Corporation wanting an "electrician in charge" at £90 per annum, and the Blackpool Corporation a mains superintendent at £2. 10s. a week. The payment is not princely, but to an American calculating the "living wage" on a basis of everything about twice as dear as in England, the amounts must seem particularly absurd.

Lightning Conductors.—The "lightning conductor question" still occupies a place in the columns of the *Centralblatt der Bauverwaltung.* The main question debated is the circumstances of the little understood induction stroke and also the range of protection afforded by a conductor. Prof. S. Moormann, writing from Gustemunde, contends strongly that with proper earths a good lightning conductor greatly increases the security of buildings in the neighbourhood under all circumstances. A proposition which, it may be ventured to say, few greatly doubted.

Asynchronous Motors.—It has been pointed out by Mr. Görges in Germany that there may be more than one possible speed for rotary-field motors. For instance, in the simplest example, with the winding on the armature round only one axis, the speed may tend to approximate either to synchronism or half speed, according to circumstances. This is considered as being an extreme case of a law applicable to all polyphase motors. The case referred to above has been taken advantage of practically. With other less simple arrangements, however, it will probably be found that the extra speeds are mostly theoretical only.

Electric Working on the Underground.—It may be worth noting that besides the "low-level" electric express line, which may or may not be proceeded with this session, the District Railway are seeking parliamentary powers to work their existing line by electricity. That this will be done eventually few doubt, and everybody hopes that it will be done speedily, but the difficulties are considerable, not only on account of the heavy character of the trains and their frequent stoppages, but also in regard to matters outside the province of the engineer, and due to the fact that there are something like half a dozen different companies running their trains over the line.

The Junior Engineers.—Mr. McDougall's paper on "Electric Central-Station Working," which was to have been read this (Friday) evening, is postponed to December 18. On Friday last a large number of the members of the institution paid a visit to the works of Messrs. John I. Thornycroft and Co., at Chiswick. They were received by Mr. John Thornycroft, jun., and dividing into small parties were shown over the various sections of the extensive works, and, at the conclusion of the visit, on the proposal of the chairman of the institution, Mr. H. B. Vorley, the thanks of the members were conveyed to Messrs. Thornycroft for the interesting afternoon which had been afforded them.

Cable Interruptions.—The official list of cable interruptions for last month (up to the 25th) given in the Berne *Journal Télégraphique* states that communications are still unrestored over the Puerto Plata and Martinique cable (failure last December), the Trans-continental African line beyond Mazoe (March 11), and the Salisbury and Umtali lines (July 11). The Columbian land lines which stopped working on July 4 are not open, nor is the Parà and Maranham cable, which failed on October 8. The Amazon Company's cable (May 4) has been got to work again as far as Parintins. The only other failures are some unimportant ones in Asia and the Malay Archipelago, which in no case exceeded one day's duration.

The Clydebank Cell. — Such a disproportionate amount of fuss has been made about the Clydebank (Macdonald) battery that it may be just as well to state briefly of what the combination consists. Beginning from the inside, it has in the middle a zinc rod in a solution of common salt, then the porous pot, and outside that a spiral of copper wire buried in cinders, the whole being bathed in a solution of copper sulphate and contained in an outer vessel or pot. The novelties are, of course, the cinders and the salt. Any electrician can pretty well judge what the cell is worth, but the above was the combination which caused such a very astute person as the editor of *Truth* to talk about two Scotch lads finding energy enough in a jam-pot to take a steamer across the Atlantic.

Electric Tramways.—The *Journal des Transports* has published some statistics which show the development of electric tramways in Europe during the past year, the number of lines in working order having increased from 70 to 111, while the total length of lines has gone up from 437½ miles to 564. As to length of line, Germany heads the list with a total length of 255 miles and has 857 motor vehicles, France is second with 82½ miles and 223 vehicles, while England is third with 67 miles and 168 vehicles, Switzerland coming fourth with 29½ miles and 86 vehicles. Bulgaria and Denmark are the only countries which have no line with electric traction. Of the 111 lines now being worked, 91 are on the overhead wire system, while nine have a central rail, eight accumulators, and three an underground conduit.

Telegraph Wire Contraction.—It is stated that on Monday morning telegraphic communication between London and Dover and the Continent, *viâ* Chatham, Sittingbourne, and Canterbury was entirely cut off for a short time, the whole of the wires snapping asunder

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through frost. The breakages occurred at Newington, near Sittingbourne, "where, without the slightest warning, the wires, which had contracted through the action of the keen frost, snapped, and fell into the road." (The frost was not particularly keen, though it felt cold enough, but presumably the strong wind helped.) A strong party of Engineers from Dover repaired the damage. As described above, the breakage seems rather curious, as the thermometer temperature which determines metallic contraction was not nearly severe enough on the date to get outside the usual allowance.

Mr. Bose's Protest.—There has been during the week a curious sort of triangular dispute between the *Daily Chronicle*, *Pearson's Magazine*, and Mr. J. Chunder Bose, the complaint of the latter being that between them those two publications have been making him talk pretty considerable nonsense. We are inclined to think it is our big neighbour the *Daily Chronicle* that is most in fault; but anyhow it does not much matter, because everyone who has read Mr. Bose's British Association paper knows perfectly well that he is incapable of the ridiculous statements attributed to him, and so far as the general public is concerned all that would happen would be a general idea that Mr. Bose had "done something or other fresh with electricity." But it may well be a matter incomprehensible to an Indian why the popular Press should be content to display such stupendous ignorance on a subject on which information is so easily procurable as the various applications of electricity.

Filament Temperatures.—Mr. P. Janet has presented a note to the Paris Académie des Sciences on the application of Mr. Violle's results as to the law regulating the specific heat of carbon between 0 and 1,000 centigrade in order to obtain the temperature of an incandescent lamp filament. If the applied P.D. is varied slowly, the E^2/R and R curve gives the loss by radiation. Again, if an R and t curve (t is the time, the other letters have their usual signification) is made by measuring the change of resistance as the filament cools when the circuit is broken, from this, in conjunction with the other curve, a third curve can be deduced, the area of which gives the total radiation loss. Assuming the Violle formula, the only other quantities required are the mechanical equivalent of heat and the weight of the filament. No results of any attempt to apply this method are given. Moreover, it is very questionable whether a lamp filament could be relied upon to accurately follow the Violle law.

The Civil Engineers.—At the meeting of the Institution of Civil Engineers on Tuesday last, Mr. J. Wolfe Barry, C.B., F.R.S. (president), in the chair, it was announced that 18 associate members had been transferred to the class of members—viz., Messrs. J. Atkinson, C. R. L. M. Bonn, A. W. Brightmore, M.Sc., V. E. de B. De Broë, W. Henderson, T. H. B. Heslop, F. Kensington, P. G. Messent, H. F. Parshall, W. A. Legg, T. Roberts, J. A. Saner, H. B. Taylor, F.C.H., W. Taylor, J. Trump, W. C. Tyndale, G. B. Walker, and L. S. Zachariasen. At the same meeting it was reported that 96 candidates had been admitted as students. To-night (Friday), at 8 p.m., there is a students' meeting for an address by Mr. J. Wolfe Barry, C.B., F.R.S. (president), and a paper to be read ("Railway Signalling") by Mr. David W. Kinmont, Stud.Inst.C.E. On Tuesday, December 8, at the ordinary meeting, the papers to be read are: (1) "Tipping and Screening Coal," by Mr. James Rigg; (2) "Surface Plant at Kirkby Colliery," by Mr. Thos. Gillott, M.I.C.E.

Royal Society Dinner.—The Royal Society dinner on St. Andrew's Day was, as usual, a big affair. Lord Salisbury wrote that he could not come—"cogent reasons"—and Mr. Chamberlain was dining at Windsor. The Speaker responded to the toast of "The Legislature," which the president (Sir. J. Lister) said was the best on the face of the earth. He should be an authority on some kinds of constitutions, and he thinks the British Constitution is an excellent one. The American Ambassador proposed "The Society," and the President responded, and proposed "The Medallists." After some more about Röntgen rays, as a sort of supplement to the afternoon, he referred to Mr. Moissan's work and Prof. Grassi's discoveries as to the process of development in eels. Those investigations had cleared up a question which had long been a source of mystification to biologists. Mr. Henri Moissan responded (in French), and there were other speeches by Sir J. Lubbock, Lord Rayleigh, Prof. Rücker, and the Lord Mayor. The anniversary meeting of the society is the subject of another note.

The British Association.—The final meeting of the British Association Local Committee was held at Liverpool on Monday, the Lord Mayor in the chair. The final report of the executive said that the late meeting of the association was of unusual interest and importance. The attendance, though not so great as in Manchester or Newcastle, was 3,181, and the amount of money available for grants to committees for the advancement of science was greater than had been known for a number of years. The average attendance for the last 10 years had been 2,209, and the average amount of money distributed in grants £1,062, while at the recent meeting the amount of money distributed was £1,355. It was usually considered that a British Association meeting cost, roughly, £1 per head, but the Liverpool meeting cost only £2,625. The balance in the treasurer's hands was about £980, which the committee advised should be invested and the income therefrom paid to the Liverpool Marine Biology Committee for use in the publication of scientific proceedings and the prosecuting of scientific research. The report was adopted.

Physical Society.—At the meeting of the Physical Society on Friday, November 27, Prof. Rücker, vice-president, in the chair, the president (Captain Abney) described and exhibited some apparatus for giving diagrams of the efficiency of a photographic shutter. In addition to the "speed" of a shutter, which is concerned with the interval between the moments when the shutter admits the first and last rays of light, it is important to know the efficiency of the shutter, which may be defined as the ratio between the time integral of the aperture uncovered and the product of the maximum aperture and the time of exposure. The necessity of considering the "rebound" of the shutter and the fact that it must not always be assumed when working with shutters that the exposure should vary as the inverse square of the aperture on account of some shutters having a very small efficiency for oblique rays, were the main facts of practical importance brought out. At next Friday's meeting (December 11) the papers for discussion are "The Application of Physics and Mathematics to Seismology," by C. Chree, Sc.D.; and "Musical Tubes," by R. J. Rudd.

Forthcoming Events.—To-day (Friday) the Cycle Show opens at the Crystal Palace. There is also a students' meeting of the Institution of Civil Engineers for a paper on "Railway Signalling," by Mr. D. W. Kinmont.—On Monday, December 7, Prof. Lewes's third Cantor lecture on gas is delivered at the Society of Arts, and at Manchester the Northern Society of Electrical Engineers hear Mr. Blount's paper on electrolytic bleach and alkali production. This is also the opening day of the Smithfield Show.—On Tuesday there is a meeting of the Civil

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Engineers (colliery plant; details are given in another note).—The Society of Arts meeting on Wednesday is for a paper on "Mining at Great Depths," by Bennett H. Brough, Assoc.R.S.M.; Prof. H. Bauerman, F.G.S., will preside (John-street, Adelphi, 8 p.m.).—On Thursday, December 10, is the annual general meeting of the Institution of Electrical Engineers (Civil Engineers', Great George-street, 8 p.m.).—On the same evening the Dundee Institute have their annual dinner at Dundee.—Next Friday, December 11, the Physical Society meet at Burlington House at 5 p.m. ("Seismology" and "Musical Tubes").

The Atlantic Telegraph Memorial.—The Executive Committee stated in their report that they had resolved: "(1) That a bust of the late Sir John Pender, at a cost not to exceed £500, be erected in the Imperial Institute or other suitable place; (2) that a sum of not less than £5,000 be placed in trust with the council of University College, London, to form an endowment fund for the maintenance of the electrical laboratory in that college, on the condition that the council name the laboratory the 'Pender Laboratory,' and the existing chair of electrical engineering the 'Pender Chair of Electrical Engineering'; (3) to endow a 'Pender Scholarship' in connection with electricity at Glasgow." On this coming up for confirmation by the full committee last Friday, the Chairman (the Marquis of Tweeddale) said he had got a letter from Lord Kelvin suggesting that a Pender medal in connection with electricity should be provided at Glasgow as well as a scholarship, and, on the motion of Mr. Underdown, Q.C., it was agreed that the third resolution be altered in accordance with this suggestion. On the proposition of the Chairman, seconded by Mr. J. C. Lamb, the three resolutions were then approved and adopted.

Ventilation of Armature Cores.—The American Siemens and Halske Electric Company have introduced a somewhat novel system of armature ventilation. The device is described by the *Electrical World*, and is fitted to the large ring cores of the type largely used by the Siemens firm. Between every two of the arms a hole is left in the core for ventilating purposes, and at equal distances from each other in the construction of the armature are ventilating spaces with which these ventilating holes communicate, and thus the surface cooled by the current of air is increased. The method of forcing the air into the holes is unique and different from that used on any other existing machine. Driven tightly in each hole is a pipe of precisely the same shape as a clay tobacco pipe, except that the internal dimensions are much larger. One set is turned in such a direction as to scoop the air as the armature rotates, and the other set, which is on the star side, is arranged to point outward, and the powerful draught caused by the centrifugal fan-action of the arms draws the heated air out, and there is thus maintained a constant circulation of air within the core of the armature. It would be interesting, though not specially to electrical engineers, to know what are found to be the best angles at which to set the in-draught and out-draught scoops.

Motorcarts.—Mr. G. H. Grant has been writing from Cambridge to protest against a motorcart race (on a racecourse, not on the roads) being held next May. He says it will be uninteresting. Probably; but that is for the public to decide. Moreover, he draws on his classical experience of chariot races to show that vehicle races must be dangerous. They have trotting matches in America without killing anyone. The real original first motorcart has been discovered by Miss (or Mrs.) Mary Dickes. It was invented in Paris in 1642, and went with "ressorts." Possibly these were not springs, and the machine certainly did not go. The Parisians were always an imaginative race. That the use of benzoline for motors by people who were not accustomed to its ways would result in accidents was pretty certain. The first took place on Monday. On its way to Liverpool from London a motorcar broke down at Whitchurch. It was taken to Messrs. Huxley for repairs, and when underneath the car one of their men accidentally turned the benzine tap with his shoulder while having a lighted candle in his hand. Assistance was at hand, but he was badly burned. The car was only slightly damaged. Hardened as they are to that sort of thing, the prospectus of the British Motor Syndicate has been too much for the City editors. They have gone for it with a unanimity which is hardly usual. Whosoever wishes to read more about motorcarts must seek it under the "Chamber of Commerce."

A Clerical Protest.—The Rev. P. Clementi Smith has written from the Rectory, St. Andrew's-hill, E.C., the following to the *Times*, and the *Times* has printed it, though, it is true, only in an odd corner: "We have narrowly escaped a very serious explosion at one of the largest electric transformer stations in the City, near the north entrance to St. Andrew's-by-the-Wardrobe, and immediately opposite my rectory. About mid-day so imminent was the danger that the police had to practically close the street to all desirous of passing up or down, and I, having gone for a short walk after morning service, was for a time unable to re-enter my house. The danger was caused by the hydraulic main bursting and flooding the electric transformer. Another foot of water and there would have been a fearful explosion. Not long ago there was an explosion near here, on Ludgate-hill, and there have been, and, I fear, are likely to be, similar explosions. Surely it is a fearful risk allowing these transformer stations to be in public thoroughfares." Could not someone inform the Rev. Mr. Clementi Smith that, desirous as it is for various reasons to keep water out of transformer sub-stations, in the matter of explosions it is gas, not water, that one has to look out for? Fortified with that knowledge, he would have been able to have set his parishioners a splendid example of the maintenance of an even mind during circumstances of severe peril—to the property and interests of the electric supply company.

Heterogeneity of Rontgen Rays.—Prof. Roiti has communicated to the Accademia dei Lincei some observations showing that there is a selective absorption of the Röntgen radiations when passed through metal foils of the same character as that produced by coloured media on ordinary light. It appears that if an attempt is made to determine the relative transparency of various metals to the rays, the results are in agreement with themselves only so long as foil of one kind of metal is used. If combinations of two or three metals are used as a screen, the results differ from what would be obtained by taking the sum of the opacities of the separate sheets, as judged by their effect on the fluorescent screen. Aluminium, brass, and tin were the metals experimented with. Further work in this direction is much wanted, not only on metals, but on substances of greater transparency and under specified conditions of voltage, vacuum, and description of tube that will allow of exact repetition. Until something like a "monochromatic" radiation is procured, it is simply waste of time to attempt wave-length measurements, either by diffraction methods or otherwise, with any of the fluorescent screens or sensitised plates already in use. The experiments of Mr. Porter and others with a Wimshurst machine as a ray generator would tend to show that radiations of a much greater penetrating power than the ordinary Röntgen rays can be produced, and that the range of the difference in character which would corre-

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spond to variation of wave-length is really very considerable.

Temperature Inside a Geissler Tube.—Starting from the fact, which is obvious even to the unscientific person who has handled a chimney lamp, that gas at a temperature above red heat may emit absolutely no light whatever, it might easily be assumed that the temperature of the glowing residual gas in a Geissler or other vacuum tube was really very high indeed. E. Wiedemann and Hittorf, as well as Warburg, have stated cautiously that the temperature of the residual gas when emitting light was probably well below red heat, a conclusion which ought not to be very difficult to arrive at when the small total amount of heat emitted is considered. Mr. R. W. Wood has recently endeavoured to settle the matter definitely, and his results have been published in the *Physical Review*. In order to obtain the different temperatures in different parts of a stratified discharge he used a bolometer, consisting of a loop or spiral of very fine platino-iridium wire. The constant current was used from a 600-cell accumulator battery, and the tube was a Hittorf one. The details of the experiments and the results would occupy too much space to be set out here, but in every case it seems that the rise of temperature as measured in the way indicated is only a matter of from 2deg. to 40deg. C., according to the gas used and its pressure. The temperature is lower in the dark spaces than in the bright ones, so that it is clear that a part of what was measured was simply "light" measured as "heat." The method is not free from difficulties, but the results so far as they go support the contention that if it were only possible to use it a vacuum tube method would convert a greater proportion of electrical energy into light than any other means of electric lighting. Unfortunately, there seems little or no likelihood of it being or becoming possible.

Medals and Officers.—The Royal Society medals have been presented as follows: the Copley medal to Prof. Carl Gegenbaur, For. Mem. R.S. (received by Count H. Hatzfeldt, of the German Embassy), for his researches in comparative anatomy, and especially in the history of the vertebrate skeleton; the Rumford medal to Prof. Philipp Lenard, and also to Prof. Wilhelm Conrad Röntgen (received by Count H. Hatzfeldt), for their investigation of the phenomena produced outside a highly exhausted vacuum tube through which electrical discharge is taking place; a Royal medal to Sir Archibald Geikie, F.R.S., on account of the great value and importance of his many original contributions to geology; a Royal medal to Prof. Charles Vernon Boys, F.R.S., for his invention of quartz fibres and investigation of their properties, his improvement of the radiomicrometer and investigations with it, for developments in the art of instantaneous photography, and for his determination of the value of the constant of attraction; the Davy medal to Prof. Henri Moissan, Paris, for the isolation of fluorine and the use of the electric furnace in the preparation of refractory metals; the Darwin medal to Prof. Giovanni Battista Grassi (received by the Italian Ambassador). On this list foreigners can hardly complain that they are unfairly treated. The society have elected the officers and council for the ensuing year. The following is a list: President, Sir Joseph Lister, F.R.C.S., D.C.L.; treasurer, Sir John Evans, K.C.B., D.C.L., LL.D.; secretaries, Prof. Michael Foster, M.A., M.D., D.C.L., LL.D., and Prof. Arthur William Rücker, M.A., D.Sc.; foreign secretary, Edward Frankland, D.C.L., LL.D.; other members of the council, Prof. William Grylls Adams, M.A., Prof. Thomas Clifford Allbutt, M.D., Prof. Robert Bellamy Clifton, M.A., William Turner Thiselton Dyer, C.M.G., Prof. James Alfred Ewing, M.A., Lazarus Fletcher, M.A., Walter Holbrook Gaskell, M.D., Prof. Alfred George Greenhill, M.A., William Huggins, D.C.L., Prof. Charles Lapworth, LL.D., Major Percy Alexander MacMahon, R.A., Prof. Raphael Meldola, F.C.S., Prof. William Ramsay, Ph.D., Lord Walsingham, M.A., Prof. Walter Frank Raphael Weldon, M.A., and Admiral William James Lloyd Wharton, C.B.

The Arc in Gases.—Mr. W. A. Bone, Mr. D. S. Jerdan, and Mr. J. C. Cain have been investigating the chemical combinations produced by the arc in various gases. In view of the increased use of enclosed arcs, any investigations in this direction have some interest. From the results given in the *Proceedings* of the Chemical Society it would appear that in pure, dry hydrogen methane was formed, and acetylene, as well as other unsaturated hydrocarbons. There were small quantities of hydrocyanic acid. From the experiments, however, it would appear that the arc will decompose hydrocarbons as well as form them. When the electric arc is passed between carbon terminals in an atmosphere of hydrogen, acetylene and methane are both produced. Further, the rate of formation of these two gases is fairly rapid during the first 15 minutes of the experiment, after which the rate falls, and finally after about half an hour, a state of equilibrium between the hydrogen, acetylene, and methane is attained. This equilibrium depends to some extent on the voltage employed. These results led to the inference that methane and acetylene would both be decomposed by the electric arc, and that if the arc is passed long enough a similar state of equilibrium would be arrived at. This conclusion was fully borne out by subsequent experiments, in which pure acetylene or methane was subjected to the action of the electric arc passed between carbon terminals in the same apparatus as that employed in the experiments with hydrogen. Both methane and acetylene are easily decomposed by the electric arc; during the first 10 minutes of the experiment, the gas (methane or acetylene, as the case might be) was very rapidly resolved into its elements, large flakes of carbon were formed in the neighbourhood of the terminals, and fell to the surface of the mercury below; the gas in the globe underwent a great increase in volume, much greater than could be accounted for by the mere expansion of the gas by the heat of the arc. A smoky flame rose from the terminals and filled the upper part of the globe. At the end of about 10 minutes this extraordinary appearance subsided, after which the arc presented the same appearance as in the case of the hydrogen experiments. After the arc had passed for an hour, the experiment was stopped; samples of the gases were then collected and subsequently analysed. The principal product in each case was hydrogen with about 9 per cent. of acetylene, and small quantities of methane, nitrogen, and hydrocyanic acid. In the experiment with acetylene a minute quantity of naphthalene was also formed.

Royal Society.—The anniversary meeting was on Monday last (St. Andrew's Day). The president's (Sir J. Lister) address was in the main an historical review of the scientific events of the year. As a preliminary, however, it was stated that the council had been occupied with the consideration of the proposed standing orders relating to the conduct of the meetings and to the publications of the society, the object being to increase the interest of the meetings by giving greater freedom in the conduct of them and by enlarging the opportunities for discussion, and to obtain a more secure and at the same time more rapid judgment as to the value of communications made to the society, so that while the high standard of the *Philosophical Transactions* was retained, or even raised, greater rapidity in

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the publication of them and of the *Proceedings* might be attained. One of the most important events of the past 12 months was the conference of delegates to consider the drawing up a complete catalogue of scientific literature. The president, further in his review, dealt at some length with the Röntgen radiations. Early in the past session the announcement of Röntgen's great discovery burst upon the world. Its wonderful applications to medicine and surgery attracted universal attention to it, and physicists everywhere had since been engaged in investigating the nature of the new rays. Perhaps no outcome of such enquiries had been more remarkable than the fact observed by Prof. J. J. Thomson, F.R.S., that the rays had the power of discharging electricity, both positive and negative, from a body surrounded by a non-conductor, a mass of paraffin wax, for example, behaving in their path for the time being like a conductor of electricity. [Prof. Silvanus Thompson says that paraffin and solid insulators generally do nothing of the sort.] It appeared that Lenard had before observed the discharge of both kinds of electricity through air by the rays with which he worked. Lenard's rays, however, differed from Röntgen's in being deflectable by a magnet, implying, in the opinion of most British physicists, that they were emanations of highly electrified particles of ponderable matter, while Röntgen's were regarded as vibrations in the ether. The question naturally arose whether Lenard might not have been working with a mixture of Röntgen's rays and his own. Very important researches had been made both by Lord Rayleigh and Prof. Ramsay into the physical properties of the new substance, helium, discovered by Prof. Ramsay in the previous session. Among their most striking results was the fact ascertained by Lord Rayleigh that the refractivity of helium was very much less than any previously known, being somewhere between three and four times less than that of hydrogen, the lowest that had before been observed, although helium had more than twice the density of hydrogen. And equally surprising was Prof. Ramsay's observation of the extraordinary distance through which electric sparks would strike through helium—viz., 250mm. or 300mm. at atmospheric pressure, as compared with 23mm. for oxygen and 39mm. for hydrogen. The density of helium appeared to vary slightly according to the mineral source from which it was obtained; and that circumstance seemed to give countenance to the opinion arrived at by Lockyer and also by Runge and Paschen, from spectroscopic investigation, that helium was not a perfectly pure gas. But whatever other gas or gases might be mixed with it, they must be as inert chemically as the main constituent, for all Prof. Ramsay's elaborate attempts to induce it, or any part of it, to combine with other bodies had entirely failed. Prof. Roberts-Austen, in the Bakerian lecture, had furnished evidence certain metals were capable of diffusing into each other, not only when one of them was in the state of fusion, but when both were solid.

The Chamber of Commerce.—On Tuesday Major Flood Page addressed the London Chamber of Commerce on the subject of "Motor Vehicles." Mr. W. H. Willans presided, and the council-room in Eastcheap was crowded. Major Flood Page has joined the ranks of the name-makers. Early in his address he brought out his particular fancy. It is "auto-motive." And after having joined a Greek pronoun to a Latin adjective to make an illegitimate English substantive, he called other people's inventions in the name way "hybrids." Major Flood Page criticised the Local Government Board regulations, but appeared to think that they would hardly be permanent. The speed regulations would prove unworkable even if it were possible to correctly estimate the speed. What would be the position of an electric omnibus limited to six miles an hour preceded and followed by ordinary 'buses going a little under seven miles? Two brakes were unnecessary. He protested against the action of the Chancellor of the Exchequer in inserting into the Act an iniquitous clause to the effect that after January 1 auto-motives should pay an additional duty of excise of two guineas for one ton, and of three guineas for two tons. That simply meant there would be two classes of omnibus, one paying 15s., the other £3. 18s. (Another objection not noticed was that this may tend to a weak and flimsy build in a certain class of vehicle in order to get it just under the taxable weight.) It was the old road authorities that killed the steam carriages which ran successfully years ago, and their modern successors had shown the same spirit in asking the Local Government Board for the most stringent regulations. (It is curious that these popularly elected bodies in no way reflect the popular opinion, which has been favourable to motorcarts throughout.) As to the future type of motor carriage, Major Flood Page said that in country districts he expected to see steam and petroleum employed, while he had confidence in the future of electricity as the propelling power in the towns. There was no branch of electricity in which improvements were going on so surely and so rapidly as they were in connection with secondary batteries. The development of auto-motives opened up a large field of commercial possibilities, and he thought they were destined to change the entire face of war. He believed that they would be used not only for transport but for artillery. (An artillery horse with a shot in it may be a nuisance till it is cut adrift, but it does not go off like a boiler.) Auto-motives had settled the question of light railways. Who would put down light railways at a cost of £2,000 or £3,000 per mile when the work could be done by auto-motives, which would be cheaper and just as efficient? Auto-motives would change, and ought to change, the entire position of the agricultural industry. Major Flood Page referred to the butter imports. The *Electrical Engineer* is not an agricultural journal, and therefore it is not necessary to discuss why the English agriculturist finds that he can import butter cheaper than he can grow it. One can easily agree that motor vehicles will prove of great service in country districts without assuming that they will be mainly laden with butter and eggs. Lastly, Major Flood Page believed that the final forms of motor vehicles were not yet invented, and urgently deprecated rash company speculation, which must result in the loss of money. Mr. B. Redwood began the discussion, and was followed by Mr. A. R. Sennett, who thought it waste of time to invent new names when it was simpler to prefix "motor" to the name of the particular kind of carriage that was referred to. (For once in a while we agree with Mr. Sennett.) Also, Mr. Sennett rather liked two brakes, a strong and a weak one; but his audacious defence of speculative companies on the plea that they did not cause an actual loss of money, but only took it out of one man's pocket and put it in another's, was hardly received with complete seriousness by the Chamber of Commerce of the greatest commercial city in the world. Mr. Jacobs said carriage-builders would design graceful and artistic shapes for the new vehicles as soon as the engineers had settled what the motor was to be; and Baron George de Reuter said that the experience of Paris, "where they are the worst drivers in the world," showed that the automobile was about a hundred times safer than the horse-drawn vehicle. Mr. Walter Hancock also spoke, but the Count de Torre Diaz, who was present, refused an invitation.

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BRIGHTON TO ROTTINGDEAN.

In our issue of November 8 last year we gave an illustrated description of a unique railway then under construction. This railway, known as the Brighton and Rottingdean Seashore Electric Railway, was formally opened by the Mayor of Brighton on Saturday last. It will not be necessary, except to a brief extent, to recapitulate our description of November last year and that of Mr. R. St. George Moore's given in our issue of July 3 last. The pioneer electric tramway of Great Britain was that constructed by Mr. Magnus Volk at Brighton, and opened by the then mayor in 1883. This tramway commences at the Aquarium and ends at Paston-place groyne. At that early period of electric traction Mr. Volk often mentioned to the present writer other schemes for the use of electrical energy at Brighton—such as a lift from the Madeira-road to the road above; an extension of the tramway through a tunnel on to the Downs. These ideas have not been carried out, but another—the one just inaugurated—has. From Paston-place groyne to Rottingdean is a little over three miles. The foundation of the railway is upon chalk covered during a large part of the day by the sea, so that the work of construction was arduous, costly, and only carried on at low water. Besides these mechanical or engineering difficulties, others arose due to rights over the foreshore and changes in design found necessary in carrying out the work. All these difficulties have been overcome, and the line has been opened. The accompanying illustrations will give an idea of the car of this unique line as it will usually be seen. It is placed upon a platform supported by four hollow steel columns. The permanent way consists of two pairs of rails, the outside rails being 18ft. apart, while the weight carried is about 40 tons, so that the stability of the concern is very great Fig. 1 shows the car and a part of the station at the Paston-place groyne. It might be stated that the car will carry about 150 passengers, that the rate of travel is from six to eight miles an hour, the bottom of the car is some 24ft. above the rail level, and that it has sometimes to run through 16ft. to 18ft. of water. Fig. 2 shows the car a little further out from the station, the poles carrying the wires to convey current to the trolleys. Two 25-h.p. motors are used, and geared through the hollow steel columns to two sets of wheels.

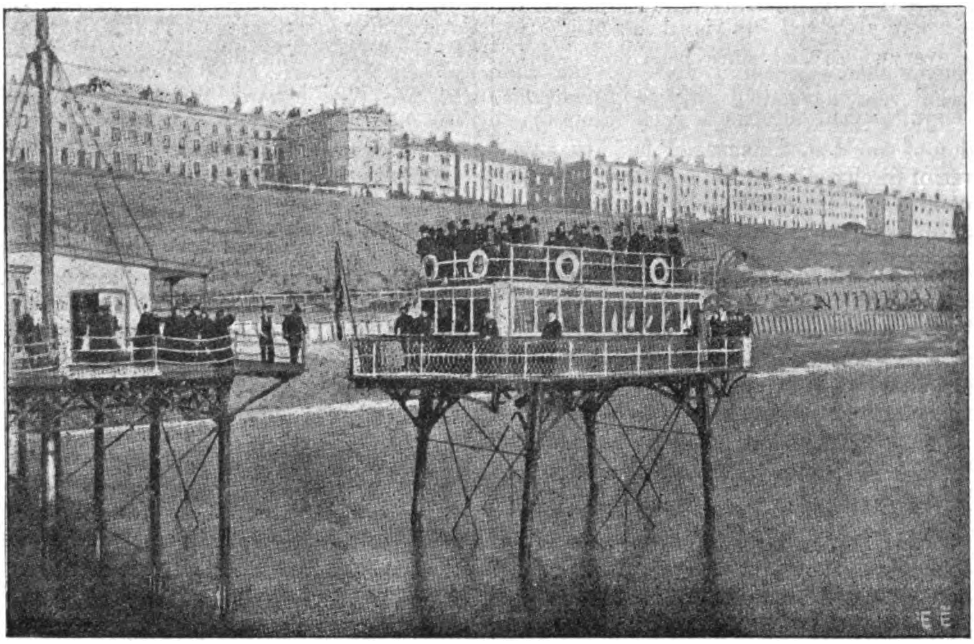

Fig. 1.

On Saturday last the Mayor, in his official robes, accompanied by the Lady Mayoress, the members for Brighton, most of the members of the Corporation, and several ladies and gentlemen invited to take part in the ceremony assembled to inaugurate the scheme within a few minutes of the appointed time. The Mayor turned a switch, the car started, and the railway was declared open. One of the members for Brighton, Mr. G. Loder, was taken a short distance, the car was reversed, and returned to the station to allow him to leave as he was unable to stay throughout the whole ceremony. Again the car started, ran steadily to Rottingdean, and returned to Brighton. The guests then proceeded to luncheon at the invitation of the directors of the company, Mr. E. O. Bleackley, the chairman of the company, occupying the chair. An excellent luncheon was served, and the toast list commenced with "The Queen"; then followed "The Mayor and Corporation," proposed by the Chairman and responded to by the Mayor. At the conclusion of his response the Mayor proposed the success of the new line, wishing it all success. All that was said on its behalf we cordially endorse. The next toast recognised the labours of the engineers, Mr. M. Volk and Mr. St. George Moore. Everyone agreed that to Mr. Volk the conception of this railway was due, and he is to be congratulated at having in some measure obtained credit for the labour he has devoted to the development of electric traction at Brighton He, with his colleague Mr. Moore, has had many a knotty problem to solve, many of which would have stopped an ordinary man; but Mr. Volk is not an ordinary man, otherwise there would have been

Fig. 2.

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no opening ceremony. Each engineer having responded, the occasion was wound up by toasts to the Press and to the ladies. There were many points in the speeches to which we should like to refer, but, like other folks, reserve to ourselves the liberty of alluding to them at some future time.

ELECTRIC TRAIN-LIGHTING ON THE SOUTH-EASTERN RAILWAY.

The improvements made in rolling-stock on the main trunk lines in recent years have frequently been mentioned in our columns. The changes in design have been chiefly in the substitution of corridor carriages for the older single-compartment type. In these corridor carriages, however, the compartments are still provided to meet, we suppose, the English desire for isolation when travelling. As a result, the compartments, supposed to hold six passengers, three on either side, are not comfortable when full. It has been left for the South-Eastern Railway Company to go still further and abolish the compartment altogether. This company has provided a completely new train for the London-Hastings service modelled on the American vestibule type. This train will be run as an express to town and back each day for the benefit of City men living at Hastings and St. Leonards. It consists of two first-class carriages, one second, and three thirds. All the carriages, which are about 50ft. long, are supported on four-wheel bogies, with transverse springs, and are connected together by flexible vestibules. Thus, a passenger can walk from one end of the train to the other if necessary. The grouping of the seats in the first and second class carriages is varied according to the purpose for which they are devoted, but in the third the seats are placed transversely, provision being made for two passengers on one side of the gangway and one on the other. This gives most ample space for all, but somewhat reduces the carrying capacity. Thus a third-class carriage will provide accommodation for 38 passengers, while the first and second hold 24 each. The heating is effected by hot-water pipes placed all round the floors, and each carriage has its own heating apparatus. This consists of a slow-combustion stove of the Baker type, placed near the lavatory, which heats up a low-pressure boiler. The temperature is regulated by the attendant to be about 50deg. F. The ventilation provided consists of adjustable louvres, with ornamental glass panels placed between the alcove roof and the upper deck roof. The windows are arranged to open upwards, which is a distinct departure from the English practice. In the large compartment the regulation of these windows to suit the majority of the occupants is likely to provide, perhaps, the only objection to the new carriages. The main saloon in the first-class carriage is nearly 30ft. long, and is fitted chiefly with revolving chairs. In their present well-oiled condition these chairs are apt to revolve with the motion of the train unless the passenger takes a firm bearing for his feet. Polished oak is largely used in the decoration of this saloon, while the upper parts are covered with Lincrusta Walton.

One of the chief features, however, is the design of the electroliers, which are far more ornamental and useful than the now orthodox type. These are fixed to the upper deck roof, and consist of four polished brass scrolls clamped together and supporting two lamps each. The lamps are provided with iced shades, which give a good diffused light, so that one can read in any part of the carriages. The distribution of lamps is somewhat as follows: The main saloon above mentioned has eight 10-c.p. lamps, while the smoke-room adjoining has three. Lamps are also placed in all the lavatories and in the vestibules, so that about 16 lamps are required in the carriage. The other first-class car is divided into two saloon compartments. The roof panels consist of decorated Lincrusta Walton, and highly decorated side quarter panels of the same material are introduced, the other panels consisting of Hungarian ash, having bandings of Thuya veneer and oak. One saloon compartment is trimmed with old gold-coloured frise velvet of floral design, and the other one, which is similarly decorated, is trimmed with blue frise velvet. The second-class car is divided into three compartments. At one end of the car is a ladies' compartment, to seat four persons, which is trimmed in Louis XV. style. In the third-class cars the decorated work is carried out in solid oak, and carving is introduced in various places. A pleasing feature throughout the train is the introduction of many photographs of Hastings, St. Leonards, and neighbourhood. The lavatory accommodation throughout the train is ample, there being two lavatory compartments to each car.

Leaving, now, the general details of the train, we come to the electric lighting gear. This has been supplied by Messrs. J. Stone and Co. to meet the requirements specified by Mr. W. Lennard, the able telegraph engineer of the South-Eastern Railway Company. Mr. Lennard has had one of these electric lighting gears on trial for some time, and from the results of this experiment advised the adoption of the system for the new train. The general principles of the Stone apparatus, designed by Mr. A. B. Gill, were described in our issue of November 29, 1895, but in the present case some new details have been introduced. Each carriage is equipped with its own dynamo and accumulators, so that it is completely self-contained. The dynamo is driven by means of a 2½in. link belt from a pulley on one of the axles of the carriage. The novelty in the system is the means of getting constant voltage independent of the speed at which the train is going. Instead of allowing the speed of the dynamo to vary, and regulating the magnetic field to correct for this, the dynamo is suspended so that its weight gives the necessary tension to the belt. The weight of the machine and the torque on the armature then exactly balance each other at normal output. Any further effort causes the dynamo to be

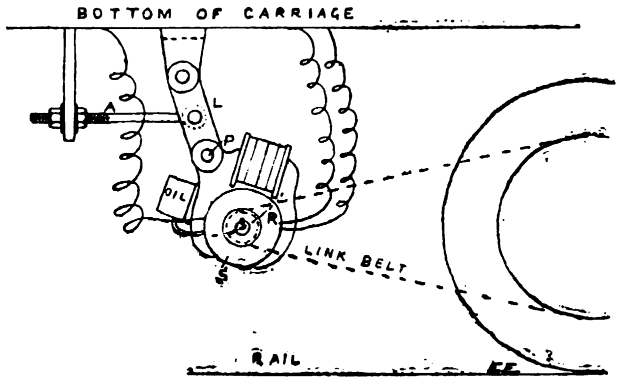

FIG 1.—Diagrammatic Sketch of the New Type of Stone's Train-Lighting Gear.

pulled nearer to the driving axle. This slackens the belt and allows it to slip over the dynamo pulley. Thus a condition of equilibrium is reached, and a further increase of speed is impossible. In the older types the dynamo was hinged directly on to the bottom of the carriage. Now the arrangement shown in Fig. 1 has been adopted, and the addition of the extra link, L, gives a greater range to the possible output. With this link in the dynamo hinges about the point P, the centre of the armature describing the arc, R. The rod, A, then provides means for shifting the position of the point of support, P, relatively to the centre of gravity of the dynamo. In this way the critical speed, and hence the output of the machine, can be varied easily; also any alteration due to stretching of the belt can be corrected without the somewhat lengthy process of taking out links. The general design of the dynamo itself can be seen from the illustration, but all the parts are encased in dust and damp proof covers. Arrangements are made in the case so that the armature connections are reversed with a reversal of direction of rotation. An automatic switch, worked by a small governor on the shaft, closes first the shunt circuit and then the main circuit as the speed increases to the normal. The inverse operation takes place as the train slows up. The accumulators, which are of ample capacity, are placed in two wood boxes under the carriage. One of these boxes is fixed on each side exactly under the centre of the carriage. The lids are easily reversed, giving ready access to the cells. There are 16 of these to each carriage, the plates being contained in teak boxes. The dynamos on these carriages

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give about 35 amperes at full load. The lamps used throughout are of 10 c.p. at 30 volts.

The lamps in each carriage are controlled from the attendant's recess. A switch in this turns one-half or the whole of the lamps as may be required. In the daytime half the lamps only are burning, but the dynamos are then charging the batteries. Near the switch a small ammeter is fixed so that the current given by the dynamos at any time may be read. This indicates when the rod, A, needs to be tightened up. The bulk of the fittings used are of polished wrought brasswork, as mentioned above, and carry two lamps. In the smoking compartments there are a few single-light wall brackets of a similar type, and in the lavatory and vestibules a simple bronze bracket is used.

All concerned in the electric lighting of this new train are to be congratulated on the successful character of the work done. We are also pleased to note that the quantity of light is not varied with the class, but that the third-class carriages have the same number of lamps as the first. We understand that the Stone system of train-lighting is finding favour with railway engineers. This is shown by the fact that although it was only introduced last year, some 33 railway companies have tried it, while orders for 1,500 sets are now in course of execution. The new train will be much appreciated by the travelling public, and by its comfort will render the popular health resort of Hastings more accessible.

RAILWAY BLOCK SIGNALLING.

BY J. PIGG.

(Continued from page 599.)

The latest form of the tablet instrument is shown by Fig. 95, and the electrical connections, in diagram, by Fig. 95A. In this form the electrical portion is confined to the unlocking of the commutator. Tablets are inserted and withdrawn by means of the slide shown at the bottom of the instrument. The operation of unlocking the instrument is performed by the distant station depressing the bell plunger for a specified time, during which the commutator is turned. A consideration of the diagram will show that, as in the other instruments described, the action of the current from the distant station is confined to the operation of the relay, and that the actions resulting in the release of the apparatus are due to the local current. It will, however, be noted that this instrument differs from the others in that the signalman at the station which requires a staff is not called upon to contribute in any way towards the completion of the path of the local releasing current. At the same time he is actively engaged in the operation at the same time as the signalman at the distant station, since he must complete his portion of the work during the time the bell plunger is being depressed at the distant station.

It is of considerable importance in tracing the action of these instruments that the movements required to release or insert staffs and their order be clearly understood. For this reason the following extracts describing the movements in their proper order are taken from official instructions.

"If a train or engine is at station A, and requires to proceed to station B, the signalman at A must give the proper 'Is line clear' signal to B, the signalman at B, having ascertained that the line is clear for the train to run upon, must repeat the signal; if not prepared to accept the train he must give one beat of the bell or gong. The signalman at A, after receiving the proper acknowledgment for accepting the train, must then give five rings: thus, 4—1, signifying 'Release tablet.' B must, provided the previous train has passed his box and there is no obstruction on the line upon which the approaching train is to run, repeat the signal back to A. The signalman at A must, if the old pattern of instrument is in use, press down the bell plunger and keep it down till the galvanometer needle rises to its normal position, which shows that the signalman at B is turning his lower disc; the signalman at A must then immediately release the bell plunger and press down the switch plunger, and keep it down till the upper disc is turned red, showing the word 'out,' then release the switch plunger, lift up the check, draw out the tablet slide, give one beat of the bell or gong, then give tablet to driver. The signalman at B must, after receiving the tablet from the driver, deposit it in the instrument, lettered side downwards; then give the 'Train arrived' signal to A and immediately turn the lower disc to white, showing the word 'in'; then press down bell plunger, holding same down for three seconds. The signalman at A

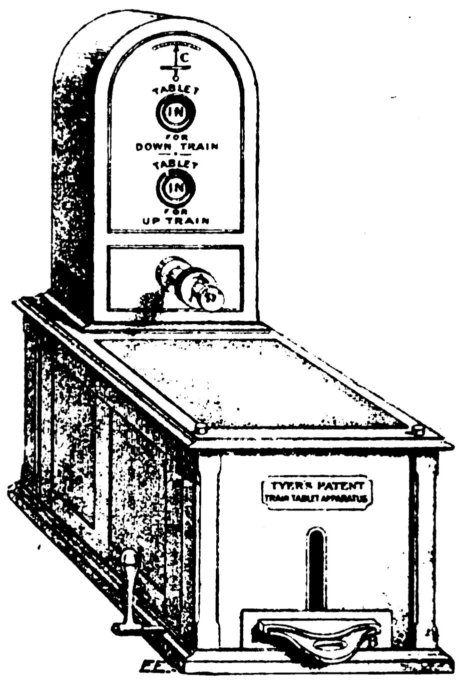

Fig. 95.

must, after receiving the 'Train arrived' signal from B, press down the switch plunger, holding down the same till the upper disc is turned to white showing the word 'in.' Both instruments will then be in their normal position." The instrument referred to in the above extract is shown by Figs. 93, 93A, and 94.

"If the new-pattern instruments are in use, the signalman at B, if prepared to accept the train, must, after

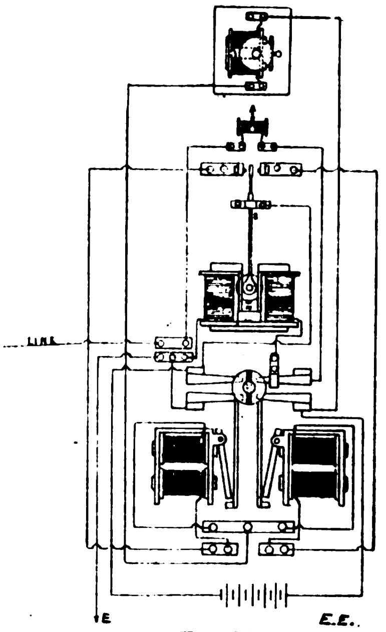

Fig. 95A.

acknowledging the signal, press down the bell plunger for three seconds; if not prepared to accept the train, he must give one beat of bell or gong. The signalman at A, after receiving the proper acknowledgment for accepting the train, must turn his lower disc commutator from right to left, showing the word 'out,' then draw out the tablet slide, give one beat of the bell or gong, then give the tablet to the driver. The signalman at B must, after receiving the

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train tablet from the driver, withdraw his tablet slide empty, insert the tablet, lettered side downwards, push the slide home, raise and lower the switch lever on left-hand side of the instrument, then give acknowledgment of arrival signal. This will have the effect of reversing the upper disc at B from 'out' to 'in.' B will give one beat in reply, which will have the effect of reversing the lower disc at A. Both instruments will then be in their normal position." The instrument referred to in this extract is shown by Figs. 95 and 95A.

Consideration of the design of these instruments will show that the objects aimed at are precisely the same as those aimed at in the construction of the train staff instruments already described, although the means by which these objects are attained are, of course, entirely different in the two forms of instrument. The ultimate object is, of course, the conversion of the line between any two stations forming a section into an up or a down line as necessity requires and circumstances allow. Both forms of instrument are, in so far as their application is concerned, simply developments of the simpler single staff system which they have replaced, and rely for their advantages over the original system on the greater number of the symbols of authority to proceed which their design enables them to control effectively. No deviation from the fundamental principle of the original system is made; the only difference is that the authority to proceed through the section is available at either end as circumstances require. This, of course, is often a matter of great importance in reducing the delay to traffic to a minimum, but the rigid adherence to the original principle of staff working makes instruments such as the train staff or tablet unsuitable for working in conjunction with intermediate block sections, which, as has already been remarked, is of considerable use for facilitating the passage of traffic in one direction, where the single staff and ticket system is in use. With such systems as those described, block working as a safety device is unnecessary, owing to the absolute control established by the instruments over the staff or tablet used; indeed, such instruments themselves constitute a form of absolute block in that they rigidly impose a space limit between trains passing through the section they protect. At the same time the staff section constitutes the minimum length of block section, and the length of these determines the facility with which traffic can be handled under certain conditions.

It is questionable whether the rigid adherence to the principle of the simple staff shown by the design of the instruments described is really so necessary as it would appear to be. It will be noted that the line is converted into an up or a down section, as the case may be, *at the moment* the staff, tablet, or other recognised authority to proceed, *is withdrawn from the instrument.* Further, the design of the majority of the instruments is such that it is not *necessary* for the symbol to be conveyed to the opposite end of the section in order that the line may be made neutral, as is shown by the arrangements for supplying staffs or tablets for local shunting purposes, such staffs or tablets being returned to the instruments from which they were taken. The handing of the symbol to the driver for conveyance to the other end of the staff section is a relic of the requirements imposed by the original single staff system, in which the staff was absolutely necessary to the conversion of the line from a neutral state to an up or a down section as the case may be. With such instruments as those under consideration the conveyance of the symbol and its insertion in the other instrument is only necessary in consequence of their designs being modelled upon the requirements of the original staff system, and is really a serious disadvantage in that it leads, where the traffic does not balance, to the necessity for special transference of symbols from one point to another in order to allow of continuous working. In so far as possession of the staff or tablet constitutes the driver's authority to proceed, the use of the "ticket" in the single staff system shows that any subsidiary authority will suffice for his purpose so long as it is recognised. This is, of course, leaving out of consideration the fact that entrance to the section is controlled by the fixed mechanical signals in addition to the staff or its equivalent.

Further consideration on the lines indicated would show that with proper precautions a "staff and ticket" system, with one staff only at each end, in which the *staff* would never leave the station at which it is placed, and would be used only as a means to liberate a subsidiary authority of a similar nature to the ordinary "ticket," would appear to have many advantages. With such a system the line could be converted into up or down at will, and ordinary block working could be carried on in conjunction in order to facilitate the passage of a number of trains in the same direction, the number of trains proceeding in the same direction in any one *staff* section being determined by the number of intermediate block sections, these latter being in accordance with experience of the traffic on the line. Such a system as here outlined would not be difficult to devise, and would involve nothing extraordinary in the way of apparatus, whilst it would appear to meet all the requirements of single lines.

(To be continued.)

SOME NOTES ON THE COMPARATIVE COST OF SUPPLYING LIGHT BY GAS AND ELECTRICITY IN MANCHESTER.*

BY G. E. STEVENSON, M.I.C.E.

From time to time comparisons have been made between the cost of lighting by gas and by electricity, and much divergence of opinion has been expressed as to the relative value of the two methods of illumination. The chief obstacle in the way of arriving at an agreement on this matter has been the difficulty of determining upon a common basis for the calculations to be made. Indeed, to institute a full and exhaustive comparison is fraught with almost insuperable difficulties owing to the dissimilar nature of the elements to be considered. On the side of electric lighting would have to be considered the expense a consumer is put to in renewals of lamps, and the saving he would realise in regard to decorations. On the side of gas there would be the expense incurred in not extinguishing gaslights but leaving them turned down. For these considerations we have no definite data to base a comparison upon. I therefore propose to confine myself in this paper to the question of cost of supply, leaving out of consideration all advantages or disadvantages incurred on the consumer's premises.

On the subject of comparative cost some interesting information was given by Mr. W. R. Chester in his inaugural address to the Gas Institute this year, and if the basis of comparison which he adopted be accepted as correct, the results are very favourable to gas lighting. After careful consideration I am of opinion that the basis upon which Mr. Chester founded his comparison is a fair and reasonable one, and I propose to follow the same lines in dealing with the results obtained by the Manchester gas and electric light undertakings. I am, however, bound to tell you that this basis is objected to in the electric light department, for reasons to be hereafter explained.

The Corporation electric light station was started in 1893. The development of the undertaking has been very rapid, and it now ranks first in the list of provincial electric light installations. At the close of the last financial year the number of incandescent electric lamps supplied was 89,294 of 8 c.p., to which standard, for comparison with other undertakings, all lamps of larger size are reduced. There were, in addition, 806 arc lamps and 47 motors supplied with current from the conductors of the station. The total length of conductors was 113½ miles. The undertaking has been singularly successful financially, and in the last year of working a profit of £11,138 was realised, notwithstanding a reduction in the charge from the original price of 8d. per unit to 6d. per unit.

The generating plant originally put down was during the last year fully utilised. The area of supply comprises the best streets of the city and the majority of the largest consumers of light. The supply has not hitherto been

* Paper read before a meeting of the Manchester District Institution of Gas Engineers. Extracted from the *Journal of Gas Lighting.*

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extended into second-rate or suburban districts. The conditions of consumption are very favourable. The average consumption of current works out to over 20 units per lamp per annum, and, on the basis of comparison which I have adopted, to about three times the average consumption of gas by the gas consumers. It is therefore evident that the Manchester electric light undertaking was during the last financial year in a most favourable position for carrying on the supply of electric energy economically, both as regards cost of production and charges on capital account.

In calculating the cost of supplying light by electricity, the basis taken is the equivalent in Board of Trade electrical units to 1,000 cubic feet of gas of the average illuminating power produced at the Manchester gasworks during the year over which the gas and electric light accounts simultaneously extend. The gas manufactured is tested twice a day at each of the stations, and the average of all the tests made is the figure which is published in the accounts of the gas department. This figure is 19·55 candles for the year ended March 31, 1896. The equivalent in electrical units is determined by the average rate of consumption of electric energy in incandescent lamps per candle-power of light given out. This is the crucial point in the basis of comparison. Mr. Chester took an average of four watts per candle per hour. This is a rate which has been regarded by electricians as a good average, and I think it is a fair one to take. There are lamps which yield a higher efficiency; and if these lamps were equally durable with those of lower grade, and if they retained their high efficiency, the argument in favour of taking the highest efficiency lamps as the standard would be a strong one. We have it on the authority of electricians that they do not comply with these requirements, and that, in fact, no electric incandescent lamps retain their initial efficiency permanently. As we are taking no account of renewals of lamps, and, moreover, not test the gas in high-efficiency burners, it would be unfair to take other than an average efficiency as the basis of our present calculations.

A Board of Trade unit being 1,000 watts, and four watts being consumed per candle per hour, it follows that one unit consumed per hour is productive of light equal to that of 250 sperm candles. One thousand cubic feet of 19·55 candle gas consumed in one hour in suitable burners, each burning at the rate of five cubic feet per hour, is productive of light equal to that of 3,910 candles. Dividing this figure by 250, we obtain a quotient of 15·62, which may be taken to be the equivalent for lighting purposes in electrical units of 1,000 cubic feet of Manchester gas. Now, if we take the total quantity of electric energy accounted for in units in the electric lighting accounts for the year, and divide that by 15·62, we shall get a quantity equivalent to thousands of cubic feet of gas sold; and with this quantity we can analyse the electric lighting accounts on the same lines as we do those of gas undertakings. Such an analysis has been prepared, and is here tabulated side by side with that of the gas accounts for the same year ended March 31, 1896.

Gas Lighting.	Per 1,000 cubic feet of gas sold. s.	d.	Electric Lighting.	Per equivalent of 1,000 cubic feet of gas. s.	d.
Manufacture—			Generation—		
Coal, less residuals	0	9.57	Coal	0	6·34
Purification	0	0·33	Oil, waste, water, etc...	0	2·31
Wages	0	2·74	Wages	0	4·79
Repairs and maintenance	0	4·30	Repairs and maintenance	0	7·78
	1	4·94		1	9·22
Distribution..............	0	1·66	Distribution..............	0	5·77
Management	0	1·94	Management	0	6·23
Rents, rates, and taxes.	0	1·78	Rents, rates, and taxes.	0	3·30
Law charges..............	0	0 01	Law charges..............	0	0·29
Bad debts.................	0	0·04	Bad debts.................	0	0·03
Net cost	1	10·37	Net cost	3	0·84
Interest and sinking fund	0	3·25	Interest and sinking fund	1	7·58
Total.................	2	1·62	Total.................	4	8·42
Revenue from sale of gas	2	3·90	Revenue from current..	6	5·76
Meter rents	0	0 33	Meter rents	0	1·84
Total.................	2	4·23	Total.................	6	7·60
Deduct expenses	2	1·62	Deduct expenses	4	8·42
Profit.................	0	2·61	Profit.................	1	11·18

From this statement it will be seen that the net cost of the gas sold per 1,000 cubic feet averaged 1s. 10·37d., while the net cost of its equivalent light value in electrical energy as consumed in incandescent lamps averaged 3s. 0·84d. Adding the charges for interest on capital, etc., we get 2s. 1·62d. for gas, and 4s. 8·42d. for electricity. The result is more favourable to the electric light than in the case of Nottingham, as the comparative cost is in the proportion of 1 for gas to 2·2 for electricity, instead of 1 to 2·73 as given Mr. Chester.

It will be noticed that the charges for interest and sinking fund are very much higher in the electric light than in the gas undertaking. The comparison is not quite "on all fours," owing to the large amount of capital which has been paid off by the gas undertaking by redemption during the long period of its existence. There is, however, no great disparity between the capital employed in the Manchester gas undertaking and that of other similar concerns, in proportion to the business done, for it is just equal to that employed by the South Metropolitan Gas Company, and but little less than at Birmingham, while it is considerably more than at Glasgow. Under any circumstances, however, the sum of 1s. 7·58d. per equivalent of 1,000 cubic feet of gas is a heavy charge on capital expenditure, and one that would not be incurred, or even approached, by any gas undertaking started at the present day in the kingdom.

The total light value of the electrical output for the year was equal to that of 115 million cubic feet of gas. A gasworks capable of supplying this annual quantity of gas in a populous district could be constructed, with mains, services, and meters complete, for £50,000, whereas £250,000 has been expended on the electric light installation. I do not mean to infer that the expenditure has been extravagant. So far is this from being the case that there probably is not another installation of the kind in the kingdom which has been established with so much regard to economy, as well as efficiency.

One item in the analysis demands our special attention—that is the cost of the coal. This is less by one-third, light for light realised, in the case of electricity than in that of gas. It would therefore appear to be true that more light may be obtained from coal by the indirect method of charging the potential energy of the coal upon electricity, than by directly raising the potential to a higher level in the form of gas. This is, however, only apparently the case, and is due to the imperfect and extravagant manner in which the energy of the gas is utilised.

A proof of this is that if the heat energy of gas be applied to produce light in the same manner as the energy of the electric current is made to produce it—viz., by rendering a suitable material incandescent—the superior energy of the gas is at once revealed. Another proof is that the heat energy of gas may, in its turn, be charged upon electricity by utilising it as motive power in a gas-engine and driving a dynamo therewith, when it will be found that 2½ times as much light is obtained from electric incandescent lamps supplied with current by this means than by burning the gas in standard test burners.

So far as manufacturing expenses go, gas has but little advantage over electricity; but when we come to distribution, we find a striking difference in favour of gas, due to the greater simplicity of the distributing plant, and the facility which gas affords for the transfer of energy to a distance at a minimum cost. Management is an item which, though proportionately high at present in the electric light accounts, is capable of reduction by extension of the business. The remaining items of expenditure are probably not capable of much alteration.

It is now proposed to extend the supply of electric current for lighting purposes into the suburbs of Manchester. I leave it to the electricians to decide whether such an extension is likely to place the electric light undertaking in a more favourable position as regards cost of production and distribution. That it will not tend towards a reduction in the capital charges is, I think, an opinion which may be safely expressed. There is no question of the practical possibility of a venture of this kind, if resolved upon; nor need the extension of the system cause us the slightest anxiety on the score of a possible diminution of the gas consumption. There is room for

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both to live and thrive. Personally, I feel that in the gas department we are indebted to the establishment of the electric light, which not only assists us much on foggy days, but has given us time to put our house in order before being overwhelmed by the rush of increased consumption of gas that is now being experienced.

Discussion.

Mr. Stevenson said, before the discussion commenced, he should like to say that he had hoped their electrical engineer (Mr. C. H. Wordingham) would have been able to be present and take part in the discussion, but he was sorry he had been detained by a prior engagement. That gentleman had informed him in general terms of some of the criticisms he would have made on the paper. Mr. Wordingham principally objected to the basis of four watts per hour for the electricity and taking the gas at 19·55 candles. He said the average amount of light the consumers got out of their gas was not at all what was shown on testing; and he considered that 12 candles would be the proper illuminating power to take, which would be equal to 10 and not 15½ units. Of course, on this basis. the analysis would turn out to be very different. Mr. Wordingham also said that, if they were to take the gas as tested by the ordinary method, they ought to take as the basis of calculation the rate of consumption in the highest efficiency electric lamps, which he said was 2½ watts instead of four watts.

Mr. S. Glover (St. Helens) said the first thing to do was to thank Mr. Stevenson for giving them an opportunity of looking into the matter of the comparison of the cost of gas and electric light. Dealing at once with the method of using the energy produced, he could not help thinking that, as electrical engineers had gone to so much trouble to see that the force they generated was properly used in suitable lamps, it was a great discredit to gas engineers that they had not done more in the past to see that the energy they produced was properly utilised. He thought it would be quite right to take in each case the highest efficiency lamps, and not the ordinary method of burning gas, for purposes of comparison. It would be better to compare the electric energy used in incandescent lamps with the incandescent gas-burner. He could not understand Mr. Wordingham's objection to their taking the highest efficiency burners for comparison, as they knew the consumers in many cases only got 50 per cent. of the efficiency produced. His visit to Bradford had confirmed him in his idea that they ought to have taken a great deal more care that the consumers properly employed the energy with which they doubtless supplied them; and they had received a rebuke from the fact that the electrical engineers were now doing what gas men could have done years ago. The whole question had not been stated. There were many advantages to be derived from the use of electric light which they would be very foolish, if they wanted to be considered engineers, to ignore. They ought to enter the consumers' premises and take the thing in hand right up to the ultimate use of the gas, because it was owing to the peculiar advantages possessed by the electric light that people were willing to pay a higher price for it. Taking all the advantages that the electric light had, the initial cost was not the true cost to the consumer. That was what they would have to deal with, because the consumers would bring them to it in the future. They must follow both supplies of energy right up to the burner before they could say that they had done the whole of their duty. Therefore, they had to face the fact that the electric light works supplied the full energy right up to the lamp, and into the most beautifully decorated rooms, without throwing on the consumer a lot of additional cost for many things that were always charged against gas.

Mr. A. H. Gibbings (Bradford) said he was hardly prepared to say very much on the paper, as, unfortunately, he was not able to be present when it was read. The exigencies of his department had called him away that day, which was another illustration of how they had to be on the spot to meet every demand upon them. The gas industry had no doubt given electrical engineers a very great task to perform, because, having been in the field so long, their works had been established, and the public had become used to a certain price per annum for their illumination. If they went in for electric light, or oil, or whatever it was, they expected to get the same amount of illuminating power for the same cost, and if they did not get it for the same cost they expected the additional outlay to be made up by other advantages. It was only in this way that the electric light could be put forward as a competitor of gas. They had to compete with the advantages possessed by the electric light, such as the conditions under which it would be used, and the absence of noxious gases given off. This, of course, was somewhat beyond the scope of the paper, which seemed to take two standpoints—first, the cost of producing, and then the cost of supplying to the consumer. The relative cost taken of supplying to the consumer would be all right where both the electric light and the gas undertakings were working together under the same committee, but where a gas company were being attacked by a corporation with the electric light a different set of considerations arose. It was very nice to draw comparisons which were more interesting to the parties concerned than to the public itself. His idea of the proper method of drawing a comparison between the cost of gas and electricity was that they should, in the first place, take a standard gas-burner consuming so many cubic feet of gas per hour of a certain standard illuminating power. By the Board of Trade regulations they were bound to supply the electric light at a declared pressure, and were only allowed a variation of 4 per cent. If the lamps were good, it stood to reason that the consumer would get the illuminating power that he bargained for, but for the purpose of comparing the cost they should base their calculations on the cost of producing the standard light, not on the cost of producing gas generally, which might vary from 12 c.p. to 20 c.p. Electric light did not vary to anything like the same extent. Therefore he deprecated general statements, as being utterly beside the mark. He had tried to get out tables of the comparative cost of gas and electricity in different consumers' premises, and had been asked by one of the biggest consulting engineers in the country to supply him with the figures. In a town in North Wales he found that one consumer who had been paying £250 for his gas only paid £90 for the electric light, while another consumer who had paid £250 for the electric light only paid £80 for his gas. All these cases very largely depended, not on the accurate comparison of the number of lights that had been installed in the place of the gas lights, but very often on the ideas of the person who made the change. The tendency with electric light was for people to instal it with a much more lavish hand than they would ever think of putting in gas lights. He should like to have had an opportunity of going into the figures and examining them critically; and he intended to do so, because they would be of great interest to him personally. His own idea was that no comparison should be made unless it were based upon some theoretical standard which was equitable and indisputable in both cases.

Mr. Thomas Newbigging said it was only a matter of fairness that they should acknowledge the excellence of the paper which they had had from Mr. Stevenson. He had given them a very simple method of comparing the value of the two lights—gas and electricity—for which they were exceedingly obliged, and would find very useful. He would also like to acknowledge the exceedingly fair way in which Mr. Gibbings put the matter before them. They did not often have it stated so fairly from their point of view. There was a good deal in what Mr. Glover had said as to their having neglected their duty in not following the gas from the retort right up to the burner; but he believed it had been more the misfortune of the gas engineer that he had not been able to do so. An Englishman's house was his castle. They could not very well go in and order a consumer to use a certain burner; he picked up his burner from the first shop he called at in the street. It might be a good, bad, or indifferent burner. But there it was; and he exercised his own discretion, and pleased himself as to what he used. On the other hand, electricians had a much more costly "burner" to supply. It was a burner that could not be made by anyone, and the electricians had a chance—he would not say of insisting on their burners being used—but the consumer had no option. Therefore, he took the burner supplied to him, which was probably the best of its kind. In this way the electrician had a very great advantage. All the same, he (Mr. Newbigging) thought there should be a little more exertion on the part of gas managers to endeavour to get the consumers to use the burner which would develop the most light. In favour of electricity, he would like to say he did not agree with Mr. Stevenson's figure for the construction of a gasworks. He said that a gasworks capable of supplying 115 million cubic feet of gas could be constructed, with mains, services, and meters complete, for £50,000. This would work out to about £450 per million cubic feet. He did not agree with this, if it included the cost of the site and of the Act of Parliament—everything, from the very beginning and establishment of the company. That was not a sufficiently ample figure. Therefore, from his point of view, it was doing an injustice to electricity. Both the interest and the sinking fund would be more if it were a higher figure. When a works was established and in full going order, extensions could be made for £450 down to £350 per million; but to establish a works capable of producing 115 million cubic feet, if everything was done in proportion to the capital, would cost £63,000. In this way he would increase the figure for interest and sinking fund—he could not say how much, because he had not worked it out. Of course, the increase would be in favour of electric lighting.

Mr. Glover said Mr. Newbigging had evidently not been in a town where they were troubled with the "gas-burner man." However much an Englishman's house was his "castle," it was always liable to be besieged by the "burner man," who made the consumer pay as much for an inferior article as he could get an incandescent electric light for in these days. The foolish consumer, who had been left to flounder about for the right method of using the energy supplied him by the gas company, gave as much for a gas burner as he would have to pay for an electric lamp.

Mr. W. W. Hutchinson (Barnsley) testified to the excellence of Mr. Stevenson's paper. He said he hoped the author would have given a little more detail with regard to the application of gas-engines to produce electricity. Mr. Stevenson had stated that by the use of a gas-engine 2½ times as much light would be obtained as by the standard test burner usually employed. But he failed to follow up this conclusion by saying what the comparison was with incandescent burners and those which gave so much more light and were in general use at the present time. In this way he did an injustice to gas in the comparison. So far as he (Mr. Hutchinson) could grasp the figures, the electric light cost, practically speaking, twice as much as gas, even taking into account the correction that Mr. Newbigging had made with regard to the initial outlay for gasworks. He should like to know if Mr. Stevenson had any figures to put before them with regard to the relative cost to a consumer of supplying fair-sized premises with the electric light and with gas with, as near as possible, the same amount of illumination. There had lately been one or two cases in his

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town, and, from the information he had obtained, he found that the most profitable way of supplying the electric light to moderate-sized premises was by using a gas-engine. He should be glad to know if Mr. Stevenson could give them any information on the point whether allowing the consumers an advantage in the shape of a reduced price for gas used in engines would be paving the way for the subsequent institution of electric lighting. So far as his information went, it was not so; but he should like to hear the latest information on the subject.

Mr. T. B. Ball (Rochdale) wished to make a remark with regard to the figure Mr. Stevenson had put before them, of 1s. 7d. for an equivalent of 1,000 cubic feet of gas as the proper charge for interest and sinking fund on an electric light installation. He could not help thinking what a load this was placing at once on electric light undertakings. It had yet to be proved that the onerous conditions which the Local Government Board insisted upon for the repayment of loans advanced to these undertakings were absolutely essential. If this very heavy charge of 1s. 7d., compared with 3d. per 1,000 cubic feet for gas, could be lightened—and he believed it would be very considerably lightened—it would be a great help to purveyors of electric light. It was a very serious item in the cost of electric lighting, and he could not help thinking it would be very materially reduced. One was driven to this conviction by the fact that private installations of electric light could be run much more economically than public installations. He believed some of his colleagues in Lancashire—those who had electric light installations in their towns—could endorse the statement that many large consumers of electric light had ceased to take their supply from the corporation because they found they could produce it much more economically themselves. This was a contingency which he thought all installations of electric light had to face. At the same time, Mr. Stevenson had told them that the total light-value of the electric light output in Manchester was equal to 115 million cubic feet of gas per annum, which was a very important factor of itself. The profit on 115 million cubic feet per annum would be a grateful addition to many exchequers; and, although it was deprecated that they should look upon the electric light as a rival, they could not get behind the fact that, to the extent of 115 million cubic feet, gas was supplanted by electricity in the case of Machester. They all of them, he presumed, had more or less experience of this sort of thing in most towns. The point he really wanted to make was that under existing circumstances the electric light installations had not quite as much free play as the gas undertakings had with reference to the expenditure and to the repayment of capital charges, and to that extent they were handicapped in their competition with gas supply.

Mr. Charles Wood (Bradford) said some of what he had intended to say had been covered by the previous speakers. As Mr. Gibbings had pointed out, the gas and electric light were worked on amicable lines at Bradford—there was practically no competition, and in this way they were able to come more accurately at the actual cost of the supply. He thought the basis of four watts per candle-hour for the lamps which they were supplying in Bradford to consumers free of charge was rather too much. The lamps which they were supplying averaged 3½ watts per candle for 1,000 hours. As electric current was supplied in Bradford at 5d. per unit, with the lamps thrown in, and the gas at practically 2s. per 1,000 cubic feet, the comparative cost of the two worked out at an average in a good many cases of something like double the expense in the case of electricity. But against this extra expense had to be set the advantages which, in the opinion of a good many people, were to be derived from the use of electricity in the saving of decorations and so on, and which more than made up for the additional cost. This was a point that was not to be lost sight of, and one which they would have to combat in the future.

Mr. S. Meunier (Stockport) said they had a fair amount of electric light in his town, but there was no public supply. With regard to the difference in the cost between generating one's own electric light by means of a gas engine and taking it from a central station, he should like to say that some time ago he was talking over this question with the electric light engineer to the London and North-Western Railway, who told him of an installation they had in Liverpool worked by a gas-engine—it was a mixed installation of arc and incandescent lighting. They had very carefully taken out the total working cost of their gas, and found that light for light the extra cost was equivalent to 3d. per 1,000 cubic feet more than they paid for the Liverpool gas. With regard to the comparisons generally made by electric light engineers, so far they had been between the best system of electric lighting and the worse system of gas Mr. Gibbings had been the first to propose something fair and square. In regard to gas, it was an extremely difficult matter to know what basis they were going to start from. Gas was very largely used not only in buildings, but it was practically the light adopted by the smaller dwellings. With the latter class they were troubled with the fact that gas had been used for a little over a hundred years; and every gas consumer thought he knew as much about how to burn gas as the gas engineer himself. The electric light people were, however, better situated. It was a new thing, and people wanting the electric light went to the engineers for advice in a way that he hoped they would come to the gas engineers. The consequence was they used good lamps and obtained the maximum efficiency from the light. Unfortunately, it was just the other way with gas. In spite of all attempts to dissuade people, they would stick to the old iron burners. They had had a little experience of the "burner man," mentioned by Mr. Glover, in Stockport, and they only wished they could get the same price for their burners as this individual got out of the customers for his. He had heard of cases where they charged 9d. apiece for the burners, and the consumption of gas had gone up 100 per cent. Then there was the influence of the plumber. People who were too busy to attend to the gas themselves, called in a plumber to set matters straight, who put on the burner the best way he could, the consequence being that the consumer suffered. He (Mr. Meunier) only brought these instances forward to show that the electric light industry was not labouring under the same difficult that gas engineers were. He still thought that so far they had not had a fair comparison between gas and electric light, and he should like to see some definite and reliable formula laid down.

Mr. R. Porter (Elland) said Mr. Stevenson had stated in his paper that the total light-value of the electrical output at Manchester for the past year was equal to that of 115 million cubic feet of gas; but he did not understand him to say that, if the electric light installation had never been started in Manchester, they would have been selling 115 millions more gas. They had heard a good deal about the advantages of electricity, but nothing about its disadvantages, other than the cost. One of the disadvantages he should like to hear something about, from those qualified to speak to it, was that of its effect on ventilation.

The President said he should like to say a word with regard to the figures Mr. Stevenson had placed before the meeting. Taking the figures of the net cost of producing gas and electricity, leaving out the interest and the sinking fund, the cost of making electricity was, on the showing of Mr. Stevenson (who they all agreed would be as fair as he could), only some 55 per cent. more than the cost of making gas. Of course, it would come to more if interest and sinking fund were included; but, as Mr. Ball pointed out, as the business increased and more favourable terms were obtained for repayment of capital, these items must of a certainty decrease. The figures divulged by the paper showed the enormous progress that electricians were making in reducing the cost of generating electricity. Only a few years ago the cost was looked upon as double and treble that of gas. But it was no longer so, and this should stimulate gas engineers to make renewed efforts to improve the cost of manufacture. As he pointed out in the early part of the year, they had to face the electric light, which, in his opinion, was a really serious matter. They were very much indebted to Mr. Stevenson for having brought the paper before them, as its usefulness would be apparent to all.

Mr. Stevenson, in reply, said he was afraid he should rather disappoint those who had asked questions of him when he said that, in entering into his reply, he should have to strike out in rather a different direction to that followed by the speakers. As soon as he went into the matter of the electric light accounts and their working at Manchester he saw that electricity was, as the president had just said, rapidly gaining on the heels of gas in the cost of production, and the question arose in his mind, was this final, or was there something behind by which they might turn the lever the other way, and show that there was a great deal to be done in the case of gas? While on the question of light-value (burning gas in ordinary gas-burners and getting light from electric incandescent lamps as supplied by electricians at the present day) there soon would be hardly any difference in cost involved, there was an enormous difference between the value of the gas and the electric current in regard to the heat energy. It occurred to him that this was the point which they had to drive at. Mr. Ball spoke about the interest and sinking fund at Manchester. He was not absolutely certain, but he thought 25 years was the period fixed. If electric light undertakings were being handicapped in relation to gas undertakings as regarded the period allowed for repayment, the Local Government Board were reducing the period for gas undertakings very much. They could not now borrow for gas undertakings for a longer period than 30 years, and they would probably be very soon put upon the same terms as the electric light undertakings. The latter might be extended to 30 or the gas companies be reduced to 25 years. The great point to consider was how properly to deal with the energy produced by the gas. Hitherto they had been expending it in a comparatively wasteful manner by consuming it in ordinary burners. It had been shown that 1,000 cubic feet of gas was equal in lighting value to 15½ electric units; but when they came to heat energy, 1,000 cubic feet of 19½-candle gas was equal to 12,000 units of electricity. This was something they could work upon. With incandescent gas-burners, they obtained about 16 candles per cubic foot, instead of four candles—at once a multiplication by four. There was no reason why these lines should not be followed up, and still greater utilisation of the energy obtained. When coal was carbonised for the purpose of making gas, something like 70 per cent. of its energy was got back again in the form of gas or in the coke and tar. But in producing the electric current by the consumption of coal in steam-boilers, the utilisation of the energy was very small, and the waste something enormous. They had to deal with boilers which gave 45 per cent. utilisation, if the coal were very good. There was a waste of 20 per cent. in the working of the dynamo, so that they only obtained about 80 per cent. of efficiency.

Mr. Gibbings: About 84 per cent.

Mr. Stevenson, continuing, said 4½ per cent. of the energy of the coal could be put in the electric current, but it did not all get there, as against 70 per cent. in the case of gas. About 24 per cent. went into the gas, 35 or 37 per cent. into the coke, and something into the tar. There was no question that they would by-and-by have to deal with gas in a different way from what they were doing at present. He had not had time to go into the details of the comparative value of an electric light

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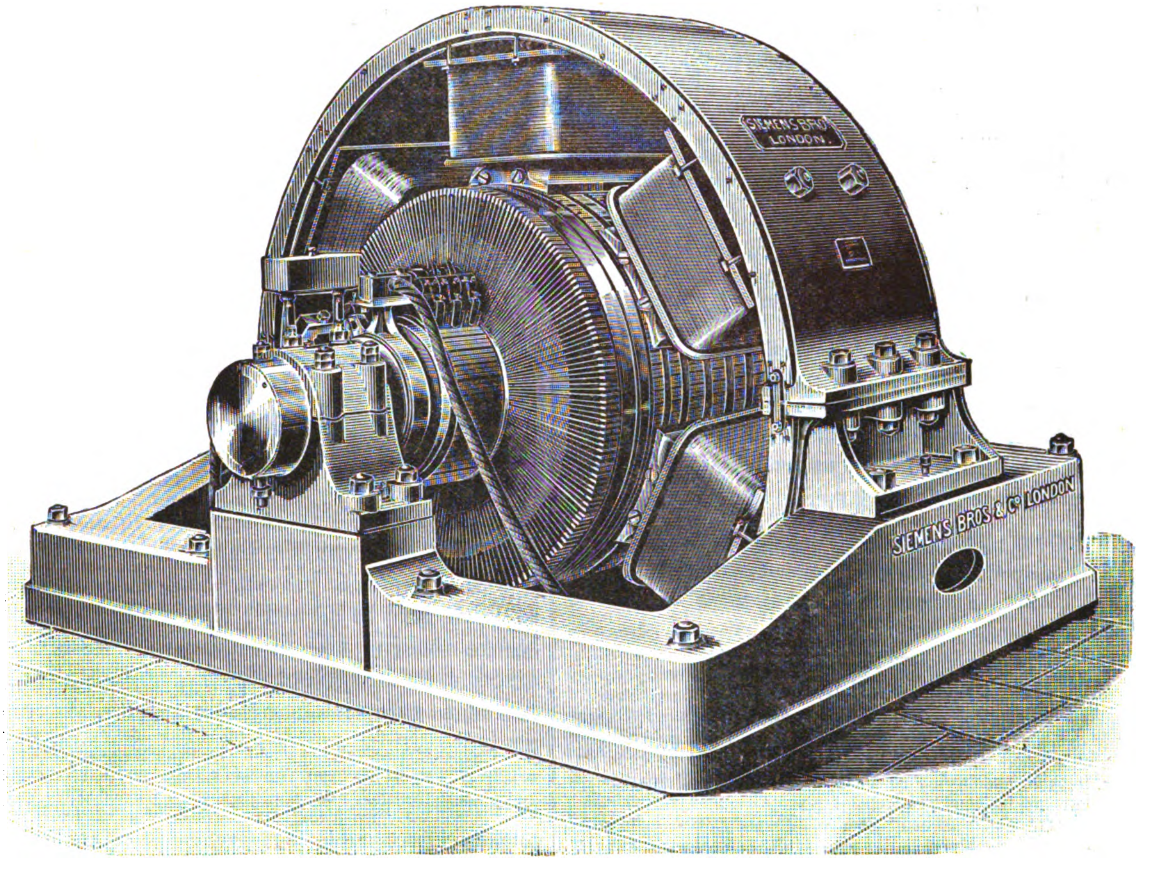
installation driven by a gas-engine and one supplied from a station. In his paper he had dealt with the supply from a central station. There was no doubt whatever that, if they had moderately large premises, an installation could be worked more cheaply with gas-engines than from a station with a steam-engine. His calculation of 2½ times as much light being obtained from electric incandescent lamps by the use of gas-engines was theoretical. They knew how much a gas-engine took per horse-power, and they also knew what was the equivalent in watts of the horse-power, so that it was a very simple calculation to get at what would be obtained in the electric lamp. As to the dispute between himself and Mr. Wordingham as to the basis to go upon, there were higher efficiency lamps than four watts, and it was quite true that gas consumers used very inferior burners. But it was not true that these high-efficiency lamps could be relied upon for a long period, nor could one depend upon any number of lamps giving 3½ watts per candle at the end of 1,000 hours, having regard to the paper which Mr. Preece read at the recent British Association meeting at Liverpool. Mr. Preece gave a large number of series tests which he had made of electric lamps—for efficiency, duration, and so on. There was a group of 16-c.p. lamps which at the end of 1,000 hours gave an efficiency of 68·3 per cent., another gave 62·39 per cent., and the best group 83·7 per cent.—the general average being 73 per cent. Then he made an installation test, in which he kept 18 lamps going for 1,000 hours in nine groups of two lamps each in parallel. During this time there were as many as 11 of the lamps broken and replaced, and at the end of 1,000 hours the average illuminating power was 9·6 candles, and the average consumption at the finish was a little over five watts per candle per hour. They were justified in taking into account that electric lamps did not maintain their efficiency constantly, and, therefore, they could not be compared with gas-burners, which, whatever their original quality might be, once put into position would give the same result if supplied with gas of the same value. He quite agreed with Mr. Gibbings as to the necessity of taking some fixed and determined theoretical standard for making a comparison, and this was what he had endeavoured to do. Of course, he had taken it on the gas side, for the benefit of gas people—that was to say, he had reduced the lighting value of electric lamps to something understandable on the gas basis. But it would be quite as easy to bring the gas down to the electric light basis. It would only be a conversion of terms. The fair and reasonable average rate of consumption for the electric lamps must first of all be determined. He took it at four watts, which he thought a very fair average. He did not bring the paper forward with the view of setting up a triumph of gas over electricity on the point of cheapness. As he had said, there were many things to be taken into consideration which it was very difficult for them to do from their standpoint, unless they went into the consumers' premises and made their comparisons there. This would, of course, make it in the end more satisfactory for a consumer to pay more for an electric lamp than for a gas-burner. A friend of his in Manchester, to whom he showed his figures, remarked that they might be perfectly right and that the electric light did cost so much more in proportion to gas, but in many instances it would be cheaper to use the electric light—meaning that it would be more convenient and more satisfactory in many respects, and in many indirect ways bring an advantage from which they would reap benefit. He was much gratified with the discussion, and hoped it would lead them all to see what they could do with the intrinsic energy of gas.

BRADFORD ELECTRICITY WORKS.

Messrs. Siemens Bros. and Co. have lately supplied two 500-kilowatt continuous-current dynamos to the Bradford electricity works, and as in this instance they have departed from their usual construction, inasmuch as the machines are multipolar, a short description of the latter may be of interest. The two dynamos are exactly similar, and one of them is shown in the accompanying illustration. They are coupled directly to Willans engines, the output of each set being 750 amperes at 500 volts, and the speed 300 revolutions per minute.



Siemens' 500 K.W. Multipolar Dynamo as supplied to the Bradford Electricity Works.

The armature is a Siemens drum with stranded bar conductors. In this instance the diameter is nearly twice the length of the pole-pieces. The commutator has 211 segments, and there are two sets of brushes placed at 60deg. angular distance apart, each set consisting of three brushes. The armature resistance from brush to brush is less than one-hundredth of an ohm. The weight of the complete armature is 6½ tons.

There are six field magnets, arranged equidistant inside a heavy forged-iron ring, which forms the common yoke, and is 8ft. in diameter over all. The pole-pieces are rather more than 2ft. across, and the wire is wound on a wooden frame. All six magnet coils are connected in series, and have a total resistance of 41 ohms. They are connected in shunt to the armature, with an intercalated regulating switch and resistance. The whole ring of magnets weighs 11 tons, bringing up the weight of the whole dynamo, inclusive of bed-plate, to rather over 21 tons.

Advantage was taken of there being two similar machines to test them by the Hopkinson method, when the following efficiencies were measured: at quarter-load, 90½ per cent.; at half-load, 94¼ per cent.; at full load, 95½ per cent.

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AS OTHERS SEE US.

We cannot always agree with the *Journal of Gas Lighting*, because generally it seems to select faults electrical for criticism and ignore all good points. Credit, however, must be given to our contemporary for its excellent report of the meeting of the Manchester District of Gas Engineers, and especially of the electrical paper read at that meeting and the discussion thereon—a report we have not hesitated to reproduce. In future, no doubt electrical journals will endeavour to be represented at such meetings. There is undoubtedly great antagonism between gas and electricity, but that is no reason why each should not give the other fair play. The rivals must fight the fight to the bitter end, and though for many reasons we think electricity will eventually win, the time of supremacy is not yet. At present, however, our object is to direct attention to Mr. Stevenson's paper. He attempts the impossible, but that is no reason why he and his readers should not learn something from his effort. The only comparison in the long run that will be effective is that made by the consumer, and he will decide, not only upon the length of his bill, but partially upon the indirect benefits which accrue from the use of electricity. The moral of Mr. Stevenson's paper is clear, and it is to show that such comparison as his cannot be made unless there is common ground for agreement. Everyone of his figures might well be disputed—all the vital figures were disputed. Thus Mr. Wordingham declines to accept as a fair comparison 19·55-candle gas and a four-watt-per-candle lamp. Certainly if we are to compare an ideal gas with an average filament consumption, the result is hardly fair. Make both ideal if you like, and get an ideal and valueless result. If both are to be real, then agree upon the facts before making the comparison. Again, two grave errors arise in the comparison of capital expenditure. A large proportion of the capital expenditure in central-station equipment and distribution is made with a view to future expansion, and as a matter of fact beyond dispute the ratepayers undertake a heavier first cost in order to prevent a future charge; hence the interest and sinking fund is out of all proportion in many cases to what it ought to be for these purposes of comparison. Besides this, as various speakers pointed out, the electrical industry has been handicapped in many directions by legal restrictions and regulations. Yet further, attention was wisely directed to the exaggerated amount of management cost in electrical undertakings. In most cases the present cost of management would be little increased even with the quadrupling of the business. Thus, in all these important items a very false impression is given by a comparison such as Mr. Stevenson makes. We are really only emphasising the opinions that were expressed during the discussion, which, we must say, seems to have been one of the best ever carried on at a meeting devoted to gas interests. There was no endeavour to palliate figures, but an expressed desire to get at the truth; to let gas engineers see exactly where they are, what they have to contend with, and to stimulate their energies by

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a firm conviction that electricity is making great headway; that it is now produced more cheaply than it was; and that in future, with its more extensive development, they may expect it to be still more cheaply produced.

THE INSTITUTION.

We are not sure that the turmoil is over, that the new Council will suit everybody, or that the Institution can look back with pride upon the past twelvemonths' agitation. But for the present we will let that pass and make a suggestion. The election to membership is to us the point which demands the utmost care from the Council. We could wish that it might become an unwritten law, a custom, that every member contribute to the *Proceedings* of the Institution a thesis as a sign or proof of his being a suitable person to take part in the work of a learned technical society. We do not believe in the examination craze. Examination never was and never will be a proof of ability. But there should be something more than nomination required. The members have certain privileges; they should show in some way to the society that they are capable of appreciating the privileges and performing such duties as they may be called upon to undertake. It is all very well to point to books written, papers read, practical experience gained elsewhere, but the Institution should receive as well as confer benefits. The Royal Academician proves before and after election his ability—why not the member of the Institution? The Civil Engineers have also an unenforced law of a somewhat similar nature; and we cannot help thinking that if this idea found root with the Council of the Electrical Engineers, it would obviate the objection many feel that some members elected on the Council have never done anything for the Institution.

THE BRITISH MOTOR SYNDICATE, LIMITED.

The issue of the prospectus of this syndicate has been well timed to prevent expert criticism. It will be noticed that the list was opened on Monday and closed on Wednesday, so that none of the engineering papers could make comment on the details in protection of the public. We agree with the statement in the prospectus that there is a danger of the directors' statements being misunderstood, and quite expect that "surprising developments will shortly be announced." The syndicate claim to hold master patents so to be able to exact royalties from all manufacturers. It will, however, be noticed that the royalties and licenses already obtained come from subsidiary companies, and not from the outside manufacturers. That various patents have been acquired is true, but it will be seen that none of the patentees hold positions in the company. Their names are used, and in several cases used without consent, to get money from the public. No opinion as to validity of the patent rights is given, and from our knowledge of the development of prime movers we should see no possibility of master patents existing at the present time. The extravagant statements as to the prospects of the company refute themselves in the eyes of all technical men, and the lack of information as to how the premium of £2 per share is to be applied should keep the untechnical investors from placing their money in the hands of the gentlemen in question.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

PERSONAL.

Sir,—As statements relating to the British Motor Syndicate, Limited, have appeared in numerous papers which are misleading to the public, and may be of injury to me if the readiest inference from them is not contradicted, I beg you will allow me to say that the reference to my name coupled with the *Engineer* was without my knowledge or authority. The owners of the patents which were bought from me for the British Motor Syndicate or Great Horseless Carriage Company are of course free to publish the fact of their ownership, but the publication should be in a form unobjectionable to the patentee. The purchase above referred to having been settled as far as I am concerned, I have no interest in the syndicate or any other motor vehicle company beyond that of any engineer who takes particular interest in the subject of motor vehicles of all kinds and in the inventions concerning them. With regard to the reference to my editorial connection with the *Engineer*, which has been made the subject of notices by advertisement, I would like to be allowed to state that my final resignation took place in July in consequence of pressure of private practice, and therefore had no reference, as might be implied from the words used in the notices to which I allude, to the British Motor Syndicate.—Yours, etc.,

W. Worby Beaumont.

INSTITUTION OF ELECTRICAL ENGINEERS, Nov. 26.

Sir Henry Mance (president) in the chair.

The list of associates and students elected was given in our last issue. After formal business, the meeting proceeded to the further discussion of Mr. Gavey's paper on trunk telephones.

The **Chairman** (Sir H. Mance) said he would like to ask Mr. Gavey to give them any information he might possess as to the interference with telephone circuits due to electrical tramways. Information on the subject would be valuable to electrical engineers.

Mr. Gavey said, as he had stated in the introductory part of the paper, the way to safety from all kinds of disturbances was in the adoption of the twisted metallic loop. If the theoretical conditions he had indicated were attended to, the Department had found that immunity was secured, but there was no way of ensuring it with a single-wire circuit.

Mr. J. E. Kingsbury asked for information as to the preference for the cross or the twist system of wire arrangement when there were many wires. He thought that there should be unity of control in the telephone service, and also made some suggestions as to nomenclature. Mr. Gavey said "pegs," where other people said plugs. As he had adopted "jack," could he not see his way also to discard "peg" in favour of the other? He (Mr. Kingsbury) would also suggest the term "visual signal" instead of "visual indicator." Mr. Preece's method of making the act of taking the telephone off the hook send the signal was excellent, and was one of those things which in virtue of the merit of their simplicity would survive.

Mr. J. P. O'Gorman, in the spirit of a student and learner, would like to know the best dimensions for the copper between any two points. The Post Office used very large copper—some people said inexcusably large—but with the prospect of signalling across the Atlantic it might be justifiable. On the other hand, the Telephone Company used a small wire. There must be some size which was the best for a given distance.

Mr. C. J. Phillips said, in reference to the boards shown at the previous meeting, there was space to spare, and consequently the signals could be made of a large size. In many exchanges every atom of space was of importance, and in that case, instead of the visual indicator, small lamps might be used. These took up no more room than jacks, and were lit up by a relay actuated from the other end of the junction wire. These had been tried with success by the Telephone Company.

Mr. Campbell Swinton had a suggestion to make which was rather a matter of business management than a technical matter,

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It was that, to avoid delay and expense, the Department should for a fixed fee undertake the task of making appointments to converse over the trunk lines – *i.e.*, if he said he wanted to converse with a man at Manchester they should communicate there and ring back to him as soon as the Manchester man was ready. The telegraph wires could be used for this if the trunks were occupied. At present it was generally the cheapest way to do this oneself by telegraphing a wish to speak at a fixed time, but that involved sending out to the nearest telegraph office.

Major-General Webber sent a long communication, which was read for him by Mr. Dane Sinclair. He called attention to the danger of allowing the analogy of the telegraph to influence the method of managing the telephone staff. In the one there was considerable clerical work, and the mechanical work was comparatively simple. In the other the communication was entirely automatic, and the arrangements necessary to get into communication were exceedingly complicated. It was amusing to hear of the Telephone Company agreeing to the alterations of the switchroom arrangements carried out by the Post Office. They, as the older hands, ought to have been the pioneers, and not to have to be instructed by comparative novices. Major-General Webber then went on to refer to the popularising of telephonic communication, and to his paper on the subject at the Ipswich meeting of the British Association last year. The main point was a suggestion that telephone subscribers should be divided into two classes, one who wanted to use the trunk wires and the other who did not. In the latter case the equipment might be cheaper.

Mr. Dane Sinclair, who was the next speaker, put aside a great portion of Major-General Webber's remarks as not relating to the subject of the paper. The permanent-current system would be right on expensive circuits bringing in a high revenue, but not necessarily on cheap short ones. With the permanent-current system used only for the trunk lines certain difficulties were avoided which would occur if it were used for both trunks and locals. As to commercial questions relating to charges he believed he could answer any unbiassed opponent, but that was not the question before them as electrical engineers.

Prof. W. E. Ayrton referred to the time when the investigation of practical problems in electrical work related almost entirely to telegraphy, and regretted that the demands of the heavier work had caused it to be so much put aside at the Institution. The telegraph was not less important now than in those days, but more important. Moreover, telephonic systems had no existence at all 15 years ago, and it might almost have been fancied that the proper discussion of all the problems involved in them would hardly leave the Institution an evening to spare for other matters. In reference to the part of the paper which dealt with electrostatic and electromagnetic disturbances, it had been investigated theoretically many years ago by Mr. Heaviside and by himself. In cases corresponding to telegraph practice say with four wires at distances of 1ft. and 1½ft. apart, vertically and horizontally, the capacity from wire to wire came out greater than the capacity from wire to earth, whereas Mr. Gavey's experiments gave it as only ·6 of the latter. He would therefore like further details as to how the experiments were made, and whether other wires were to earth or not. It was important to know the length of the circuits in the experiments between Cardiff, Swansea, and Newport. Mr. Gavey had found the electromagnetic disturbance was 30 times as great as the electrostatic. Obviously, that was a matter which depended on the distance. As to the electromagnetic disturbance, if a fixed current is sent and interrupted, by doubling the distance, say, the E.M.F. in the secondary would certainly be doubled, but so at the same time would be the resistance. Therefore if the instruments at the ends were neglected, the alteration in the length would not make much difference. On the other hand, with the electrostatic disturbance, not only in doubling the length was the skin of the condenser increased, but if the current was kept the same the E.M.F. was increased so that the average potential would be doubled. The disturbance, therefore, should increase with the distance. Another important point was the effect of the establishment of leaks upon the speed of signalling. Mr. Heaviside had referred to the effect of faults upon the speed of cables as early as 1879 in a paper in the *Philosophical Transactions*. The complete problem involving the capacity, self-induction, and resistance could be treated by Bessel functions, but when faults were introduced it got rather beyond their analysis, except that they knew that the introduction of faults must increase the speed.

Mr. W. H. Preece referred to the criticisms of the working of the telephones. These, by being transmitted from newspaper to newspaper, appeared to be immensely—perhaps a hundred times—more numerous than they really were. The Post Office cut them all out, but found they got many more compliments than complaints. The magnitude and difficulty of the work involved in the transfer of the trunk telephones to the Post Office had not been properly appreciated. It had really been very great, and the Department had spared no trouble to make their system as nearly perfect as possible. As to leaks in working, the existence of them did expedite the rate of working, except when the leaks were to earth through absolute faults in a cable. That exception was due to polarisation currents arising from electrolysis at the point of escape, and the result was a retardation. On overhead lines with porcelain insulators, if it were not so they would find the lines work quicker in wet weather when there is no electrostatic action than in dry, but they did not. It was possible, however, by putting in non-inductive leaks to obtain improved working. No direct experiments in that direction had been made by the Post Office with metallic circuits. At the British Association meeting Prof. Silvanus Thompson had called attention to the fact that a non-inductive resistance introduced between the two arms of a metallic loop might improve the rate of working. He (Mr. Preece) hoped in the course of the present or next session to bring them a paper on the subject of investigations, not only of the general effect of leakages, but upon the more important question of working telephones through submarine cables. On that matter he had started a hare, but the chase of it had not been very hotly followed up. In fact, he had come in for a great deal of hard speaking, for which he cared nothing at all. When he had worked the matter out he intended to bring it before the Institution in a paper, which he confidently anticipated would be followed by a warm discussion.

Mr. Gavey then replied. To Mr. Kingsbury's question, he might say that it was possible to use crosses in parallel wires 30 or 40 miles long, but when there were 30 or 40 wires it would be seen that the crosses became inconveniently numerous. The twist system was the best, and even then it was necessary to insert crosses occasionally to get a perfect balance. As to the question of unity of control, he was an executive officer and had nothing to do with questions of policy. He was quite indifferent on the subject of "plugs" or "pegs," but as to "visuals" in a switchroom all the signals must be "visual signals" of one kind or another, and some distinguishing word was necessary. In reply to Mr. O'Gorman, the gauge of wire would vary with the length of the circuit, but the least gauge adopted had been 150lb. wire, because in exceptional winters (say, once in 10 years) snowstorms occurred which would break down smaller gauges. Apart from that, 50lb. gauge wire would work satisfactorily for considerable distances. As Mr. Phillips had remarked, there was no reason for compression in the pattern of board adopted by the Post Office. And he was in agreement with him that something smaller might be desirable for a local service, but, though lamps looked very pretty, he feared they might prove uncertain. It was conceivable, if a filament got broken, it might be some time before the failure was noted. Mr. Swinton's suggestion, though not without advantage to the public, would necessitate reserving a certain part of the trunk lines for the purpose of making appointments, or would mean delay to others. The telephone lines were fully occupied during the busy portion of the day, and they, as a Government department, were bound to deal with all applicants absolutely in the order of application. The cost of special lines for the purpose of what Mr. Swinton wanted would be absolutely prohibitive. The task undertaken by the Department in taking up the management of the trunk lines was greater than was generally supposed and the Department would not stop until the telephonic system was as complete throughout the country as the telegraphic. Until everything was complete there must be occasions when members of the public would have to wait longer to get through than they thought right. Already in certain parts of the country the commercial business was practically carried on by telephone. In some of the large towns they had 3,000 to 4,000 conversations per diem, of which a very large proportion indeed were commercial. As to the engineers controlling the whole of the staff, the example of the great railways was against it. The engineer there did not think it worked against efficiency that he had no control over the booking clerk. He (Mr. Gavey) would greatly regret to see two classes of subscribers introduced as suggested by Major-General Webber. The inconvenience would be great and the saving insignificant—perhaps only £1 or 30s. on the original cost of the instruments. In reply to Prof Ayrton, the reduction factor of ·6 for the capacities was the result of experiments in which the other circuits were insulated and not put to earth, as the object was to obtain conditions similar to those of actual working. The observations were made between Cardiff and Swansea, and the current was put to earth at Newport and Haverfordwest. The reasons for that would be obvious. As to the electromagnetic effect, in making the experiment he was concerned only with the telegraphic and telephonic results, and used a reflecting galvanometer of several thousand ohms resistance, so that the resistance of the line was insignificant in comparison.

The Chairman thought that Mr. Swinton's suggestion of using the telegraph to help the telephone in getting through might be useful. As long ago as the sixties it was a common practice in the Persian Gulf to use sections of cable with a leak in the centre to obtain greater rapidity.

The next meeting is the annual general one (December 10).

The annual general meeting of the Institution will be held next Thursday, the 10th inst., when the new Council and officers will be elected. The list was given in our issue dated November 20, and as no other nominations have been made the gentlemen named will be elected. Hence this year the ballot is practically inoperative.

The following statement of accounts for the nine months ending September 30 will also be submitted to the meeting:

Receipts.	£	s.	d.
Annual subscriptions	2,402	16	6
Entrance fees	312	0	6
Publishing fund	1	1	0
Advertisements in the *Journal*	75	0	0
Dividends on investments—premium fund, £5. 4s. 3d.; telegraph jubilee fund, £3. 16s. 6d; life compositions, £86. 8s. 4d.; general fund, £124. 0s. 8d.	219	9	9
Interest—cash on deposit	0	18	2
	£3,011	5	11

Expenditure.	£	s.	d.
Salaries and clerical assistance	629	10	0
Accountants' fees	15	15	0
Shorthand reporter	34	13	0
Attendance, refreshments, and petty expenses connected with evening meetings	43	5	2
Printing, illustrating, and advertising *Journal*, and cost of abstracts, £617. 1s. 4d.; less cost of copies taken into stock, £57. 10s.	559	11	4
General printing and stationery	168	4	4
Insurance	9	15	0
Petty expenses connected with the library	0	10	6
Office rent, electric light, and firing	241	7	5
Postage of *Journal*, notices of meetings, etc.	239	15	1
General office expenses	38	2	6
Cost of illuminated address to Lord Kelvin	15	15	0
Petty expenses of local hon secretaries, etc.	1	12	2
Bank charges	0	17	11
Conversazione expenses (irrespective of printing and postage)	124	12	0
	£2,123	6	5
Balance carried to general fund, being excess of receipts over expenditure	887	19	6
	£3,011	5	11

The life compositions account shows investments amounting to £3,388, while the Salomons scholarship fund stands at £2,126. 19s. 3d. The building fund has now reached a grand total of £3,528. 4s. 2d., the amount £28. 4s. 2d. being the interest on investments, which has been placed to the capital account. The following is the general balance-sheet up to September 30, 1896:

Liabilities.	£	s.	d.	£	s.	d.
Premium fund				213	0	3
Telegraph jubilee fund				163	8	0
Life compositions—balance uninvested				58	18	2
Subscriptions received in advance—						
On account of 1897	£6	11	0			
On account of 1898	1	0	0			
On account of 1899	1	0	0			
				8	11	0
Salomons scholarship—balance of income account				43	15	2
Building fund—balance uninvested				28	4	2
General fund—balance as per last accounts	£3,279	18	9			
Add profit arising from transfer of investments to building fund taken at their value on July 6, 1896	221	1	5			
Add estimated value of books, etc., presented	40	0	0			
Add excess of receipts over expenditure (as above)	887	19	6			
				4,428	19	8
				£4,944	16	5

Assets.	£	s.	d.	£	s.	d.
Investments—premium fund				213	0	3
Investments—telegraph jubilee fund				163	8	0
Investments—general fund				2,308	10	7
Furniture as per last balance-sheet				200	0	0
Stock in hand of Institution *Journals* and Ronalds catalogues—as per last balance-sheet	£497	11	11			
Cost of additions in 1896	57	10	0			
	555	1	11			
Less amount realised during the current year	103	9	4			
				451	12	7
Books, pictures, etc. (other than the Ronalds Library)—as per last balance-sheet	1,093	0	0			
Add value of books and periodicals since purchased, and cost of binding	11	9	6			
Ditto, presented	40	0	0			
				1,144	9	6
Sundry debtors for advertisements in the *Journal*—viz., on account of 1895	2	0	0			
On account of 1896	75	0	0			
				77	0	0
Suspense account (Cooke's manuscripts)				49	6	11
Balance at bankers	£289	13	3			
Petty cash balance	47	15	4			
				337	8	7
				£4,944	16	5

The statement is signed by Messrs. Fred. Chas Danvers and A. Stroh, the honorary auditors, and is certified as correct by Messrs. Wagstaff Blundell, Biggs, and Co, chartered accountants.

National Traction Engine Owners' and Users' Association. The third annual general meeting of the association will be held (by permission of the Council of the Smithfield Club) in the Agricultural Hall, Islington, on Wednesday, December 9, at 4 p.m.

TORQUAY ELECTRIC LIGHTING SCHEME.

THE TENDERS.

A meeting of the Electric Lighting Committee of the Torquay Town Council was held on Monday, Alderman Kerswill presiding, for the purpose of receiving a report from the sub-committee appointed at a previous meeting, and to whom the tenders had been referred for consideration, with a view to recommendation being made by them to the committee, who in turn report to the Council. Mr. W. H. Trentham, consulting electrical engineer, was present. In response to the advertisements issued by the Corporation, 76 tenders were sent in by 48 firms for the supply and erection of the plant required for the municipal electricity works. The following is a full list of the tenders received:

Section A.—Boilers.

	£	s.	d.
Babcock and Wilcox*	£2,303	0	0
Brush Electrical Engineering Company	3,052	13	6
Crompton and Co.	2 366	0	0
Danks	2 616	10	0
Davey, Paxman, and Co.	2,951	15	0
Hornsby and Sons	2,400	0	0
Conrad Knap and Co.	2 488	10	0
New and Mayne	2,641	16	0
John Simpson	2,640	0	0
Tinkers, Limited	2,977	0	0
Fleming and Ferguson	4,999	0	0
Massingham	—		

* Recommended to the Council for acceptance.

Section B.—Steam Alternators.

	£	s.	d.
Brush Electrical Engineering Company	£9,976	16	0
Crompton and Co., Willans engines	9,455	0	0
Crompton and Co., Peache engines	8 738	0	0
Easton-Anderson, own engines	8,079	0	0
Easton-Anderson, Willans engines*	9,079	0	0
Ferranti and Co., own engines	11,229	0	0
Ferranti and Co., Willans engines	11,729	0	0
Johnson and Phillips, Peache engines	9,055	0	0
New and Mayne, Peache engines	7,455	10	0
Parsons steam-turbines	9,555	9	0
Siemens Bros and Co., Bellis engines	9 389	0	0
Siemens Bros. and Co., Willans engines	9 701	0	0

* Recommended to the Council for acceptance, the day-load plant being omitted.

Section C.—Switchboard.

	£	s.	d.
Brush Electrical Engineering Company	£838	16	0
Burbey	887	13	6
Crompton and Co.	563	0	0
Ferranti and Co.*	706	3	0
Johnson and Phillips	847	0	0
Manchester Edison-Swan Company	799	15	0
Massingham	698	10	0
New and Mayne	590	0	0
Siemens Bros. and Co.	892	0	0
White	860	3	0

* Recommended to the Council for acceptance.

Section D.—Mains.

	£	s.	d.
British Insulated Wire Company*	£7,165	3	6
Callender and Co., solid	8,568	6	4
Callender and Co, drawing-in system	9,151	17	10
Crompton and Co.	8 226	0	0
Fowler, Waring, and Co.	8,117	0	0
Glover and Co., solid system	8,712	12	1
Glover and Co. armoured and wood trough	7,550	0	0
Glover and Co., drawing-in system	8,857	6	3
New and Mayne	7,127	5	1
Siemens Bros. and Co.	9,216	0	0

* Recommended to the Council for acceptance.

Section E.—Transformers.

	10-kw.			20-kw.			30-kw.		
Brush Company	£61	5	0	£81	0	0	£100	2	0
Consolidated Telephone Company	57	0	0	72	17	6	81	3	3
Crompton and Co.	54	0	0	80	10	0	102	10	0
Electric Construction Co	43	10	0	69	0	0	92	0	0
Ferranti and Co.	85	10	0	115	10	0	141	10	0
J. Fowler and Co.	42	0	0	56	0	0	77	0	0
Glover and Co.	57	7	8	81	7	8	105	7	8
Johnson and Phillips	48	0	0	76	0	0	92	10	0
Manchester E. S. Co.	48	0	0	74	0	0	99	0	0
Nalder and Hilton*	50	0	0	74	0	0	90	0	0
New and Mayne	45	0	0	68	0	0	79	0	0
Parsons	52	0	0	76	0	0	100	0	0
Siemens Bros. and Co.	58	0	0	83	0	0	102	0	0

* Recommended to the Council for acceptance.

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Section F.—Meters.—Average Prices.

British Thomson-Houston Company	£6 10 4
Chamberlain and Hookham	4 7 9
General Electric Company	5 0 0
New and Mayne	5 2 10
Westinghouse Company	5 2 4

No tender was recommended.

Section G.—Accumulators

	Accumulators.	Maintenance.
Chloride Storage Company	£543 0 0	£55
Electric Power Storage Company	480 0 0	60
Epstein Company	661 17 0	63
Lithanode Company	564 10 0	40
Massingham	498 17 6	38
New and Mayne	400 0 0	7½% 1st year; 10% 2nd & 3rd
Pescatore	494 0 0	£32
Pritchett and Gold	534 0 0	£15 for 3 years; 25 for 5 years; 30 for 7 years
Stephen Smith	872 3 9	£87

No tender was recommended.

Section H.—Crane.

Bedford Engineering Company	£131 0 0
R. C. Gibbins	113 10 0
Isles, Limited*	109 0 0
New and Mayne	171 0 0
Higginbottom	145 10 0
Southgate Engineering Company	215 0 0
Vaughan and Son	205 15 0
Waverley Engineering Company	135 0 0
Stephen Smith	225 0 0

* Recommended to the Council for acceptance.

Section I.—Builder.

S. Blatchford, Torquay, at schedule of prices.

The above tenders amount to a total of £19,312. 6s. 6d., exclusive of the "builder" section. The original estimate of Mr. Trentham, electrical engineer, was £22,300. The chimney at the central station will be built by the Corporation.

EDINBURGH LIGHTING.

The following is Prof. A. B. W. Kennedy's half-yearly report on the electric lighting of Edinburgh. It was dated October 31, and has been presented to the Council this week:

Prof. Kennedy reports that on October 8 and 9 he made a careful examination of the plant at work in the electric lighting station and of the mains. He found the plant had been properly maintained, and was in thoroughly good working order throughout. The larger dynamos and steam-engines were giving, every evening at full load, even a larger output than that which they were originally specified to give. He considered this a very satisfactory result to obtain in regular working. Of the new plant, two steam dynamos had been delivered and erected, and the second of them was running for the first time on the last day of his visit. These machines appeared to be quite satisfactory, but their delivery was very late, and they only just arrived in time to take up the load, which had increased extremely fast. A third steam dynamo had been delivered since his last visit, and a fourth was either now on its way or would be very shortly. With these four new machines the station running would no doubt be free from anxiety during the winter, but he was continuing to press the contractors for the remaining two machines. The new steam alternator and the motor alternator were still not delivered, and in spite of everything that he had found it possible to do, it might be some weeks before they received them. This had caused some inconvenience, and had limited the working of the high-tension part of the station. Three of the new boilers had been delivered at the time of his visit, but none of them were ready for use, and he had to press Mr. Sinclair very urgently in this matter, and to insist that he should at once put on a night shift to carry matters forward. In consequence of the unsatisfactory working of the batteries, he was compelled to take them entirely off the circuit early this year, and he put them into the hands of their makers in order to bring them into order. After many months it seemed that practically no progress had been made in this direction—that was to say, that although much had been done to the batteries, their condition was not improved. He was compelled, therefore, to take the matter out of the hands of the original contractors, and obtain some satisfactory battery plates from another firm. The battery, as thus reformed, was now nearly completed, and would be very shortly on the circuit again. The total cost of the alteration would practically be covered by the retention money of the Corporation. He found the mains in good order. The extensions to the mains were in great part carried out, but were not quite completed, although all the more difficult part of the work was now done. Five additional feeders, for which the copper had been laid, would probably be connected to the station in about a fortnight from now. As to the growth of the station, he had to report that it had been everything that could possibly have been anticipated. The total number of lamps had been almost exactly doubled in the 12 months, and no less than the equivalent of 2,670 lamps in addition to these were applied for and would be connected up as soon as they were ready. The maximum load also had almost doubled in the course of the year, and it was worth while noticing that on October 14 it was already no less than 18 per cent. in excess of the maximum load attained at all during 1895, which was 7,570 amperes on December 23. It was no doubt within the knowledge of the Council that the cost per unit sold during last year was lower in Edinburgh than in any other place of the United Kingdom, and he greatly hoped from the present working of the station that its costs might occupy a similar position next year again. The indications at present were, indeed, that they might again be able next year to make a substantial reduction in price, both in ordinary lighting and also in the charge for arc lamps. He was asked at the committee meeting on October 8 to deal with the question of the establishment of something like a laboratory in connection with the electric light station. This was no doubt not a very usual thing in connection with stations; but he had found facilities of this kind very convenient in connection with his work at Westminster, and he thought that a photometer and some other instruments and appliances might be of very considerable use in dealing with the questions which might more or less frequently arise in connection with work so large as conducted in Edinburgh. The fitting-up of any laboratory of this kind could hardly cost much less than £300. When they took possession of the ground to the south of the present station and completed the buildings on it, it would be a matter to be very seriously considered whether such a laboratory might not be established. But it was worth while to remember beforehand that they might be greatly bothered by inventors and would-be inventors of new lamps and of other "improvements" in electric apparatus, who would wish them practically to test their apparatus for them, and that Mr. Newington would have to be extremely rigid in the matter to make certain that no such use was made of the place, which would have to be worked only in such directions as might yield results of definite use to the Corporation. Although the laboratory, if established, would have to be under Mr. Newington's authority, yet it would be impossible for him to spare much time to be in it, and a fresh assistant would be wanted specially to look after it. Now that the winter was coming on, and their load increasing so very fast, entailing so much additional work in the station, he would suggest that the consideration of, or at any rate the carrying out of, this scheme should be deferred until the spring time, when it would have more chance of getting a fair start than any new department could very well have just at present.

THE DOVER TRAMWAY REPORT.

At the meeting of the Dover Town Council on Tuesday, November 24, the town clerk presented the following report prepared by the surveyor and himself:

Scope of Report.—On July 28 last the Council made an order that we should be instructed to present a report showing the relative duties and cost of the various modes of tramway traction. In reporting on the various modes of traction in use on street tramways, we would point out that we have omitted much well-known detail in referring to the various modes, which it would serve no good purpose to quote, but have stated in brief the conclusions arrived at from the actual practice of those corporations and public companies with whom we have been in communication.

Various Modes of Traction.—The various modes of traction that have been adopted in this country are horse, steam, cable, gas, and electric, and oil and compressed air have been tried, but have met with no success; superheated steam has been tried in Paris. Horse traction may be at once disposed of on account of its limited speed, the wear and tear of roads, fouling the streets, and cost of working. Statistics show the cost of this system to be about 9d. per car mile. The gradients would also be too steep here, particularly if the tramways are extended to the borough boundary. Steam-engines (under which head would come the Serpollet system of superheated steam) are excluded by the provisional order. This system, in any case, is very costly, and has the disadvantages of steam, smoke, dust, noise, and smell, in addition to its unsightliness, and the street space it occupies, and is now being generally condemned by the Board of Trade. The cable system, in which the cable is driven by stationary engines, has many disadvantages, although where a very quick service is maintained it approaches the overhead electric system in cheapness. The disadvantages are the heavy initial cost of construction, the power required to drive the cable alone with no cars attached, the stoppage of the whole service in case of a breakdown with the cable or machinery, inability to make up lost time in running and to back the cars when necessary, besides other considerations. The system, apart from these points, is unsuited to Dover on account of the limited service and comparatively light traffic at certain hours of the day. Oil has been tried experimentally, but has met with no favour. Compressed air has from time to time been tried, and at the present time there are trams running on this system in Paris, but it is not a financial success.

Gas and Electric Traction.—Having dealt with the foregoing systems, and discarded them—for reasons given—as being unfit to

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recommend for your adoption, there are now the remaining systems of gas and electric traction to consider. It will be within the recollection of the committee that some weeks ago a letter was received from the Dover Gas Company, asking permission to tender in conjunction with the British Gas Traction Company, Limited, for the equipment and working of the tramways With this view, therefore, of comparing the cost of working a gas and an electric tramway, we sent to the Dover Gas Company and the Dover Electricity Supply Company the particulars and questions set out in Schedule 1. These particulars are, of course, not final or binding on you, but, with the exceptions hereinafter stated, they are those that we recommend for your favourable consideration. With the view of enabling you to compare the relative cost of these two systems of traction, we framed the questions on the basis that the contracting company would supply everything except men to act as conductors, and the laying and maintenance of the permanent way. There was also the additional reason that, in case you determined to adopt either of the answers received as a basis for negotiation you might think it right to frame a contract on the principle that the contracting company should be made responsible for efficiency in working, without being able to contend that any fault lay with the Corporation. We append the replies received as shown in Schedule 1 from (1) the British Gas Traction Company and (2) the Dover Electricity Supply Company. The comparative cost of establishing the two systems in the manner proposed would be as follows:

Gas.		*Electricity.*	
(*a*) Cars	£5,600	(*a*) Cars	£4,620
Trailers	660	Trailers	660
Machinery	1,750	Line equipment	7,500
Total	£8,010	Total	£12,780
(*b*) Cars	£5,250	(*b*) Cars	£4,200
Trailers	660	Trailers	660
Machinery	1,750	Line equipment	7,500
Total	£7,660	Total	£12,360

We have not included the cost of permanent way or conductors, which will be the same in both cases. The comparative annual cost of the two systems for the (*b*) cars would be as follows:

	Gas.	*Electricity.*
Interest on loan	£230	£371
Instalment	277	463
160,000 miles at 6d.	4,000	at 5d. 3,333
	£4,507	£4,167

Showing a saving on electricity of £340 per annum.

Gas Traction in Operation.—With the view of being able to report whether, as electricity is cheaper than gas, the latter has any such advantages over the former as would recommend its adoption, we visited the only gas tramway in England—viz., the St. Annes and Lytham Tramway, Blackpool. This tramway is not yet opened throughout its entire length, 3½ miles of the seven miles only being in use. The cars are constructed to carry 16 passengers inside and 24 outside, and weigh unloaded 7½ tons. They are fitted with a double-cylinder Otto gas-engine of 14 h.p., which is enclosed and hidden from view. Cylinders containing compressed gas for working the motors are placed under the seats and flooring of the cars. Ordinary coal-gas is compressed at a compressing station to 150lb. to the square inch, and stored in two gas-receivers. The cylinders in the cars are charged by means of an indiarubber pipe connected to the receivers. The cylinders contain about 300 cubic feet of gas, sufficient for a run of eight miles. The operation of charging occupies 1½ minutes. The quantity of gas used per car mile, including the motor and compressing plant, is 36 cubic feet. The machinery and gas-cylinders take up all available space under seats and floors, consequently there is no room to provide for the storage of gas for lighting, and this is done by oil lamps. There is a special gearing supplied to enable the cars to ascend gradients, but this is at the expense of speed. We may shortly sum up the advantages of gas tramways as follows: The sole advantage we were able to ascertain is, that a gas tramway carries its own motive power, and should any failure occur in the car no great obstruction to the traffic need occur. But it must not be forgotten that a breakdown might occur at a compressing station. The disadvantages of a gas-motor tram are: (*a*) longer time is taken in attaining full speed, and also in stopping; (*b*) the vibration of the cars; (*c*) the liability of smell from the exhaust; (*d*) slow speed at and special apparatus needed for steep gradients; (*e*) inability to provide gas illuminating power to the cars.

Electric Trams at Work.—We also inspected the electric tramways at Blackpool and Coventry. The former consist of about three miles of Holroyd Smith's open-conduit system, which has been in used for 12 years. There are many objections to this system at Blackpool, and much inconvenience is caused by sand and wet getting into the slot. It is an expensive system, and the officers and Corporation do not recommend it. The Coventry tramways have a length of seven miles of single line with passing places, commencing at the railway station and running through the city to Bedworth. The line, which is 3ft. 6in. gauge, was originally worked by steam, and is now taken over by the New Electrical Traction Company, Limited. The rails are left as they were, except that they have been bonded for the return of the electric current. The system of the line equipment employed is the overhead conductor. For the first half-mile from the station there, side suspension by means of poles with single brackets is adopted for suspending the electric cable, for the remainder of the length span wires are attached to rosettes on the buildings or to poles on either side of the road. The power station is situated about midway along the line. There are eight motorcars, seven in use and one kept in reserve. In addition to these there are two trailer cars, used on holidays and at busy times. The motorcars seat 48 passengers, 24 inside and 24 outside. They are run on a 12 minutes' service, from the railway station to the power station; and a half-hour service to Bedworth, four of the cars running through from the railway station to that place. The trams are run from 5 a m. till 12 midnight (19 hours), and the cost of working, including drivers, conductors, power, repairs to roads, plant, etc., and lighting by electricity is 5½d. per car mile. The company has not yet worked the tramways for a full year, but a dividend of 8 per cent. was earned during the first half-year. The population of Coventry is close on 50,000. The inspection of this tramway was particularly useful, inasmuch as the side suspension and span wire systems are both in use. The poles and single brackets are pleasing, and there is no objection to the appearance of them or the span wires. The general running of the cars is good, and the rapidity with which they get to full speed, or stop for one passenger, is a great consideration. The electric cable is over the centre of the track, which has some advantages over a system where it is at the side. The officers, both of the Corporation of Blackpool and the company at Coventry, particularly impressed upon us the desirability of commencing a new system of tramways with a full service, as they had found that traffic was created which would otherwise not be the case if one of a service at rarer intervals were adopted.

Overhead Electric Traction Recommended.—After mentioning the accumulator and the open and closed electric traction systems, neither of which they recommended, the report continues: We therefore recommend the overhead electric system as being most suitable, with the use of both poles with brackets, and span wires, as may hereafter be determined. In doing so, we wish to draw your attention to the action of other towns in this country. After many enquiries and inspecting tramways in this country and abroad, the committee appointed by the Glasgow Corporation, and by the Leeds Corporation, have recommended this system. It is in use in Dublin and Belfast, and there are being worked at Bristol four miles, Coventry seven miles, South Staffordshire Tramway Company 7½ miles, Isle of Man seven miles, and Hartlepool 2½ miles. In addition to these lines, there are in course of construction at North Staffordshire seven miles, and it is in contemplation to make 30 miles more in running through the towns of Langton, Fenton, Stoke on-Trent, Hanley, Burslem, and Newcastle-under-Lyme. In Manchester district a concession has been granted for 21 years of 6½ miles about to be constructed through the towns of Oldham, Ashton-under-Lyne, Denton, and Hyde. There are also three miles in course of construction at Hartlepool. The enquiries made by the various towns have led them to adopt the overhead electric system. It has proved itself to be the most efficient and the least costly, and the cars worked by it are capable of ascending gradients (as proved in actual practice) as steep as 1 in 7½. Any slight prejudice against the appearance of the poles and wires has speedily vanished when the lines have been in work. The joint report of the engineers of the boroughs of Stoke-upon-Trent and Burslem, and of the Urban District Council of Fenton, is in favour of the system. Referring to this report, Mr. Joseph Lobley, borough engineer of Hanley, writes: "I have had an opportunity of seeing the electric tramways at Havre, Leeds, Walsall, Portrush, and many cities in America, and thoroughly agree with the foregoing report. Although somewhat prejudiced in 1891 against the overhead wire system, I had not been in Boston 24 hours before I ceased to notice it as objectionable. I regard it as the only system that is practicable in this district."

An Expert's Opinion.—Having come to the conclusion that the overhead electric system is the best adapted for the tramways here, as well as the least expensive and most desirable in every way, in accordance with the authority given by the Council, we have obtained a report from Mr. Stephen Sellon, consulting civil and electrical engineer. Mr. Sellon, in his calculation, has dealt only with the smaller (*b*) cars. They can be run more frequently at less expense than the (*a*) cars. Mr. Sellon has calculated from the offer made by the Dover Electricity Supply Company, that their charge for electric power is 3⅝d. per car mile, and that he considers this excessive. Mr. Sellon has also calculated the cost if the Corporation were to erect their own power-house and construct and equip and work the tramways themselves, and he advises that, provided the Dover Electricity Supply Company will charge a moderate price and provide the suitable power plant, you cannot do better than take their supply of electric power. On comparing the result of entering into the agreement in the mode recommended with those suggested in the particulars sent to the company, Mr. Sellon shows the former method to be £516 per annum to the advantage of the Corporation. Under all the circumstances, we would recommend that you should construct the line and provide the electric equipment and cars and all labour in making the tramways, and that you should enter into negotiations with the Dover Electricity Supply Company on the basis of supply at a rate not exceeding 3d. per car mile for the (*b*) motorcars, with 1d. additional for trailers, on condition that they provide at their works the requisite power plant to your satisfaction, and agree to a sliding scale allowing a reduction in the price of a farthing per car mile for every 50,000 car miles per annum in excess of 160,000. Such an arrangement would allow of the extension of the tramways to the borough boundaries as well as to East Cliff. In making this recommendation we have left the

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question of the details to be matters of further arrangement, and of course the contract entered into will have to be carefully framed, and the Dover Electricity Supply Company subject to penalties for any failure of electric power, etc.—We are, gentlemen, your obedient servants,

E. WOLLASTON KNOCKER, Town Clerk.
HENRY E. STILGOE, Borough Engineer.

The discussion on the above report was adjourned.

HACKNEY.

The following report on electric lighting and refuse destructors has been presented to the Hackney Vestry by Mr. F. Hastings Medhurst, B.Sc., M.I.E.E. :

Gentlemen,—Since your vestry clerk, Mr. Grocott, informed me by letter, on July 17, that your Electric Lighting Committee had resolved to entrust me with the preparation of a report on the question of a combined electric lighting and refuse-destructor scheme for Hackney, I have given the subject my most careful personal attention, and I have pleasure in submitting my conclusions for your consideration.

The two most important electrical systems in vogue in England are (1) high-tension alternating current with transformers in substations, and a low tension network of mains for private supply; and (2) low-tension direct current with accumulators.

In the former system the current is generated at high pressure (from 2,000 to 3,000 volts) and then reduced by the transformers to low pressure (100 to 220 volts). In the latter system the current is generated at low pressure, and supplied to the users direct. In one or two towns high-tension continuous current has been installed, though I cannot recommend this system for adoption at Hackney. As the mains are required to transmit electrical energy, which the consumer may, at his option, utilise in the form of light or in the form of power, and as the cross-section and cost of the cables are much greater for transmitting a large than a small number of amperes, it follows that it is more economical to transmit the energy in the condition of high volts and low amperes than as high amperes and proportionately low volts. Hence, the cost of a low-tension system for Hackney would be many thousands of pounds more than a high-tension alternating-current system, and I therefore strongly recommend the latter for adoption.

But whether it is advisable for you to erect electricity supply works at all must depend entirely upon commercial considerations. At the present time there are in the United Kingdom some 90 electric lighting works in operation or in course of construction, about half this number being in the possession of companies, and the remainder in the hands of the local authorities themselves. Most of the undertakings which belong to companies were founded from two to six years ago, whilst in more than one instance the local authorities have bought or are negotiating for the purchase of the companies' works. The Corporation of Liverpool, for example, have recently purchased the plant and business of the Liverpool Electric Supply Company for £400,000, a sum very considerably in excess of the original prime cost of the undertaking. Rather over three years ago, the London Vestry of St. Pancras erected electricity supply works, and last year there was a clear working profit of £7,233, or over 6½ per cent. on the capital outlay of £110,000. Interest and sinking fund together amounted to £5,479, so that there was a net profit of £1,754 after the payment of all working expenses, interest, and other charges. Several London vestries are at present considering the construction of electricity supply works, some in combination with refuse destructors. That this is the course which ought on economical as well as sanitary grounds, to be adopted in Hackney there can be no reasonable doubt. From figures kindly supplied to me by Dr. Warry, your medical officer of health, I have been enabled to compile the following table :

Year.	Loads of refuse.	Total cost. £ s. d.	Cost per load. s. d.
1892	40,010	7,441 13 3	3 8·6
1893	39,950	7,609 4 5	3 9·7
1894	38,226	8,327 13 9	4 4·3

The above figures relate to Hackney only, the amount and cost of refuse collected in the parish of Stoke Newington having been subtracted. The figures as they stand show plainly that the expense of collecting and disposing of the refuse of Hackney constitutes a by no means insignificant charge on the rates, though when I add that the cost in 1891 was only £3,976. 6s. 6d., and in 1890 £3,875. 16s. 5d., it will be readily understood that the question is one not merely of great but of increasing importance. During the months of April, May, June, July, August, and September of the present year, the price per load has averaged 5s. 10d., very much in excess of the average cost in 1894.

Refuse destructors are in operation (amongst other towns) in Bradford, Leeds, Manchester, Liverpool, Southampton, Oldham, Warrington, and in the London districts of St. Pancras, Whitechapel, Ealing, Battersea, and Hornsey, and, so far as I can ascertain, they are in every case giving the greatest satisfaction to the authorities. The cost of collecting the refuse—especially if the Vestry itself undertakes the collection, and a fairly central site be obtained for the destructor—cannot well exceed 2s. 9d. per load, whilst the cost of burning the refuse, exclusive of interest and sinking fund, is not likely to exceed 1s. 3d. per load. Both these estimates are based on results that have been actually attained in other places, and err, if at all, on the side of caution. Assuming, then, that 4s be the total expense per load of collection and destruction, it follows that the new and infinitely more sanitary method of disposing of the refuse would effect a saving of at least 4d. per load over the prices which obtained last year, and a saving of 1s. 10d. per load as compared with this year's expenses. When it is borne in mind that the cost per load is certainly not declining, I think that it will be generally admitted that an average saving of at least 1s. 9d. per load may be safely anticipated. On 40,000 loads per annum this would give an economy of £3,500 a year, as compared with the probable results that would follow the continuance of the present method. I shall presently write this £3,500 on the revenue or credit side of the hypothetical profit and loss account which I shall submit later. My observations have forced me to the conclusion that the average weight of a load of Hackney refuse is about one ton, though the actual weights differ within fairly wide limits.

In company with your Electric Lighting Committee (one of whom is chairman of the Sanitary Committee) I have visited the destructors in operation at Leeds, Oldham, Warrington, and Cambridge, whilst I have at other times and for purposes outside this report seen most of the other destructors at work in England. As a result, I am fully convinced that ashbin refuse ought always to be taken into serious consideration as a fuel for producing at least part of the steam that is required in the working of municipal electricity supply undertaking in cases where the combined scheme is from the commencement practicable. But it must be borne steadily in mind that the primary object and function of a refuse destructor is to reduce the refuse to the least possible weight and bulk, and to render thoroughly innocuous all the offensive gases given off by the drying and burning matter. To thoroughly accomplish these very essential requirements, forced draught should, in my opinion, be insisted on, so as to produce a mean temperature of not less than 1,800deg. F. and a minimum of 1,300deg. F. during the periods of clinkering and charging. Further, the fumes from the drying refuse on the hearth should be made to pass over the hottest part of the fire before escaping to the chimney. There can be no doubt that these objects can be attained, and that the destructor may, without detriment to its efficacy as an essentially sanitary contrivance, be erected in combination with boilers, so as to raise, by means of the hot products of combustion of the burning refuse, at least part of the steam required for electric lighting purposes. At Leeds, Warrington, Oldham, and Southampton the hot gases of the burning refuse are made to produce steam under pressure in ordinary boilers. But that average refuse is of a low calorific value I have absolutely no doubt, and I do not anticipate that at Hackney more than 1lb. of water will be evaporated from 212deg. F. per pound of refuse.

I am aware that some engineers anticipate much better results, but I cannot, from my personal experience, place confidence in expectations of too sanguine a character, whilst by adopting the very best possible arrangements you would be in a position to take full advantage of the results if my calculations should eventually be found to err on the side of pessimism. When the plant, which I shall immediately proceed to describe, is fully loaded, steam will have to be provided for about 640 h.p. for not more than three hours out of the twenty-four. Now, 15 cells will be easily capable of dealing with 40,000 tons of refuse per annum. I should, however, recommend you to erect a destructor of 18 cells, so as to have three spare cells. A battery of nine water-tube boilers should be erected so as to utilise to the best advantage the otherwise wasted heat of the destructors, but I calculate that the 15 cells will then only produce heat sufficient to raise steam for 480 h.p. The destructors will, however, be generating sufficient heat to produce 480 h.p. during the whole of the 24 hours, whilst the demand for steam is only likely to exceed 480 h.p for about three hours a day. During four hours it will probably be about 300 h.p., and during the balance of the 24 hours not more than 100 h.p. Now, the simplest way to obtain the additional 160 h.p. for the three hours of probable maximum demand would be to burn coal in some two or three of the boilers—*i e*, to mix coal with part of the refuse, or to so arrange the boilers so as to render possible independent stoking with coal in the ordinary boiler furnaces in case of need. The cost of coal for supplementing the refuse during the three hours of maximum load would be about £200 per annum; £200 capitalised at 5 per cent. represents a capital sum of £4,000. Mr. Druitt Halpin has invented a very ingenious method, called after him "the Halpin Thermal Storage System," whereby the steam produced during the daytime or time of light load may be stored in cylinders and used to supplement the boiler capacity during the hours of maximum load. But the capital cost of applying the system to the installation I propose for Hackney would not be appreciably less than £4,000, whilst I should prefer to see it in operation on a fairly large scale before recommending it for adoption. A battery of electric accumulators might be charged during the daytime and discharged at night during the hours of maximum load. But here again the capital outlay and the cost of maintaining the accumulators in good repair would not justify the expenditure, so that, taking everything into consideration, I should recommend mixing some of the refuse with coal or burning coal in some of the ordinary boiler furnaces for about three hours per day, though possibly this will not be necessary during the first year's working—*i e.*, till the demand for electricity is equivalent to almost the full capacity of the plant. In two or three years' time thermal storage will probably have been tried on a fairly large scale, and if successful in actual practice it may at some future time become advisable to introduce it at Hackney.

(*To be continued.*)

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LEGAL INTELLIGENCE.

CLAIM FOR ELECTRICAL APPLIANCES.

In the Westminster County Court on December 1, before his Honour Judge Lumley Smith, Q.C., the case of Verity *v.* Webster was heard.

The plaintiffs are the well-known electrical engineers, and they sought to enforce payment of a judgment debt of £10 in respect of electrical appliances supplied to the order of the defendant.

Plaintiff's Representative said he had every reason to believe that the defendant was well able to pay the judgment debt, and he therefore asked that an order might be made for substantial instalments.

The **Debtor** appeared and said he had been ruined in his business, and was totally unable to pay. He had a wife and a large family, and was only earning 18s. a week.

His Honour said that if people indulged in the luxury of electric light they must pay for it, but in order to give defendant another chance he would make an order for payment of 5s. a month.

"ELECTRICAL APPRENTICES."

At the Thames Police Court on November 28, before Mr. Dickinson, a number of charges of obtaining money by false pretences were heard against Samuel Fynn, Commercial-road.

The prisoner was arrested on a warrant by Detective-sergeant Dicker.

Mr. Frayling prosecuted on behalf of the Director of Public Prosecutions; Mr. G. H. Young appeared for the defence.

Mr. Frayling said that the prisoner was charged with obtaining various sums varying from £15 to £40 by false pretences. He seemed to have started the frauds as far back as 1893. He described himself as an electrical engineer, and he used to advertise extensively for apprentices to learn that trade on payment of a premium. The advertisements attracted the attention of various people, in most cases superior mechanics, who approached him with a view to having their sons apprenticed. He represented that he had plenty of work, and carried on a good business, and said if the boys were articled to him for three years he would turn them out as first-class men. He would not only teach them electrical engineering, but, as he manufactured everything on the premises, boys would get an insight into the trade they would not obtain elsewhere. Each apprentice, when he went in, found some seven other boys there. They were taught nothing, as practically no electrical work was done, and they were put to the most menial occupations, such as cleaning the shop windows and filing pieces of iron. As a matter of fact, the prisoner was all the time in a very bad position. Scores of executions had been put in on the premises, and there were four bills of sale on the effects. It was evident that he obtained this money to help him along, and he considered that the prisoner had been guilty of the most heartless frauds, for not only had he taken the money, hard earned as it was, of these poor men, but he had caused the lads to waste the most valuable portion of their lives.

Charles Schmidt, a decorative artist, 38, Renard-road, Peckham, gave evidence as to apprenticing his son to the prisoner in March, 1895, on his payment of a sum of £30. The prisoner told him that his boy would learn more with him than with a large firm, as he would have an insight into every branch of the trade. His son had complained to him many times that he learnt nothing.

In cross-examination, the **Witness** said he knew his boy had been sent by the prisoner to an electrical engineer named Sax, but this was after witness had made a complaint at this court, and his application had been reported in the papers.

Edward Dudley Schmidt, son of the last witness, said that when he entered on his apprenticeship there were two lathes and three vices only on the premises, and a few tools, but not enough. There was a dynamo there, but no engine to work it. He spoke to Fynn about it, and was told by him that he was going to get an engine, but the dynamo itself was sold. The day he went in two of the apprentices were putting in a window and two others looking on. Besides filing a few tools, he had put up three electric bells and overhauled one telephone. He was taught nothing while he was there, and never had enough work to do.

Cross-examined: It was three months after he was there that he first complained of not having enough work. It was untrue to say that he was constantly at work. When he asked for it prisoner would pick something out of the window and tell him to polish it. Since he had been there he had received £15 out of the £30 back in wages.

Other evidence was given to a like effect, and the case was adjourned.

CASE AGAINST THE DUBLIN CORPORATION.

On December 1 the summons of Messrs. Oetzmann and Co. against the Dublin Corporation for failing to supply electric light to their premises, 61, Grafton-street, again came on for hearing in the Southern Police Court, before Mr. Byrne. We fully reported the first day's hearing in our last issue.

Mr. J. M. Day (instructed by Mr. Collins, Messrs. Casey and Clay), appeared for Oetzmann and Co.

Mr. Macinerney, Q.C., and Mr. P. White (instructed by Mr. Bonass and Mr. Rice) appeared for the Corporation.

Mr. Day said that since the case was adjourned, a week since, the only object his clients had in view in bringing the summons—that is, the procuring of an electric light supply—had been attained. That being all that was wanted he would drop the case, unless the Corporation applied for costs, which, under the circumstances, would be a most audacious proceeding.

Mr. Macinerney, Q.C., said that the last day the case was before the Court he stated that the electric light would be supplied in the ordinary course, and that had been done since. He asked that the summons be heard on its merits.

Mr. Byrne said he was asked to non-suit.

Mr. Macinerney said the plaintiffs had no case for a penalty, and he asked that the summons be dismissed in the ordinary way on the hearing of the case, and that costs be given to the Corporation, who had unfairly and improperly been put to expense.

Mr. Byrne said plaintiffs' complaint was that the Corporation did not supply them with electric lighting, and they submitted that the Corporation were liable to penalties not exceeding 40s a day for the long space of time intervening between January 1 of this year and the issuing of the summons. Plaintiffs relied on the twenty-fourth section of the Dublin Electric Lighting Provisional Order, confirmed by statute on June 27, 1892. The first step towards establishing liability to a penalty was to show that a requisition for a supply of electric energy under this order was served on the Corporation. The twenty-second section showed that that requisition should contain a certain specification of the premises in respect of which the supply was required; the maximum power required, and the day—not being an earlier day than a reasonable time after the date of the service of such notice—upon which such supply was required to commence. It was conceded that no notice was served containing these three requisites. But plaintiffs submitted that the Corporation, by the negotiations and correspondence which lasted between the parties from January 1, 1895, to the present month, were estopped from replying on this defect. In administering this penal statute there was no estoppel enabling him (Mr. Byrne) to dispense with the requisites and the provisional order for establishing a liability to penalties, and therefore, as the notice required under the provisional order was not served before the prosecution was commenced, he dismissed the summons, but without costs.

ACTION AGAINST THE DUBLIN TRAMWAY COMPANY.

On December 1, in the Nisi Prius Court, Dublin, before Mr. Justice Madden and a common jury, the case of Doyle *v.* the Dublin Southern District Tramways Company came on for hearing.

It was an action in which the plaintiff, Robert Doyle, an inspector of works in the sanitary department of the Corporation, sought to recover £500 damages in respect of injuries sustained by him through the alleged negligence of the defendants' servants while he was a passenger on one of the defendants' electric tramcars between Dalkey and Haddington-road. He also alleged that the defendants' tramway and plant were in a defective condition.

It appeared that on Sunday, June 28 last, he proceeded, accompanied by some friends, to Dalkey, where they remained for some time, and on the return journey the tramcar was forced and driven close up to an iron post, plaintiff was thrown against it, and in consequence sustained personal injury involving medical expense. The defendants traversed the alleged causes of action, and pleaded that it was owing to the negligence and improper conduct of the plaintiff that the alleged injuries were incurred. One of the defences was to the effect that their electric tramline was laid between iron poles erected in compliance with the Act of Parliament; that the position of the pole in question was determined by the authorities, not by the defendants; that the car in which plaintiff travelled was properly driven and conducted; and that the plaintiff, by the exercise of ordinary care, could have avoided the alleged injuries.

Mr. Dunbar Barton, Q.C., M.P., and Dr. Condon (instructed by Mr. Joseph Gleeson) appeared for the plaintiff; and Mr. D. B. Sullivan, Q.C., Mr. O'Shaughnessy, Q.C., and Mr. T. M. Healy, M.P. (instructed by Messrs. O'Connor and Dudley), for the defendants.

The jury found that the defendant company was guilty of negligence, that plaintiff could have avoided the consequences of the defendant company's negligence by the exercise of ordinary care, that the defendant company's negligence was the cause of the occurrence, and gave damages for the plaintiff, £10.

Mr. Sullivan, Q.C., submitted this was a verdict for the defendants, and **Mr. Barton, Q.C.**, argued *contra*.

Mr. Justice Madden gave judgment for the plaintiff for £10, but respited execution till after the defendant company, by a motion before the full Court, had ascertained the legal effect of the jury's finding.

MOTOR SYNDICATE LITIGATION.

In the Chancery Division, on December 1, before Mr. Justice Stirling, the case of Humber and Co. *v.* Thos. Humber and the British Motor Car Syndicate came on for hearing.

This was an application on behalf of the plaintiffs for an injunction to restrain the defendant Humber from acting as director or officer of the defendant syndicate, or in any business connected with the manufacture of cycles except on behalf of the plaintiff company, in breach of an agreement dated January last.

Counsel stated that an arrangement had been come to by which the motion would be allowed to stand till to-day (Friday), there

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being no order on the motion, and defendant undertaking to pay the costs of the day.

On these terms his **Lordship** directed the motion to stand over.

LONDON HEALTH ELECTRICAL SYNDICATE.

In the Chancery Division, on December 2, Mr. Justice Vaughan Williams disposed of the petition of D. O Hearson, Limited, for an order for the compulsory winding-up of the London Health Electrical Institute, Limited, which was formed in 1892, when it was doing a turnover of £20,000 a year or thereabouts.

The debenture-holders resisted the petition on the ground that there were no assets; and it was also asserted that the majority of the unsecured creditors opposed the winding-up on the ground that if the company went into liquidation they would get nothing, while there was some hope if the business were continued.

His **Lordship** ultimately dismissed the petition.

CONTRACTS FOR ELECTRICAL SUPPLIES

CONTRACTS OPEN.

Bolton.—The Corporation require tenders for a new steam-boiler at the electricity works.

Essen.—Among other articles for supply by tender to the Prussian State Railway Authorities at Essen on December 17 are 1,000 battery zincs.

Denton. — Specifications and tenders are invited for electric light installation. Apply to Messrs. John Lever and Co., galloon manufacturers, Denton.

Berlin.—December 10 is the date for tenders for a supply of telegraph posts to the Prussian State Railways at Berlin. Particulars 50pfg (6d.), at Schöneberger Ufer 1-4, Berlin.

Saint-Yvon (France).—Tenders will be wanted on January 31 for an electric lighting installation (to replace 1,500 gas lights) at the lunatic asylum at Saint-Yvon, in the Seine Inferieure. Application to the asylum authorities.

Madrid.—Tenders are wanted by December 16 for the supply of 20 tons of telegraph wire (copper) for the Government Telegraphs. Application should be made to la Dirección general de Correos y Telegrafos, Madrid, Calle de Carretas 10.

Brussels.—Tenders will be received at the Hôtel de Ville, Brussels, on December 11 for the supply of pipes and of some other stores necessary for the Municipal Electric Lighting Department during the forthcoming year.

The Hague.—The Dutch Waterstaat Ministry want tenders on 11th inst. for a postal and telegraphic building at Bergen-op-Zoom, and on 18th inst. for the supply of zinc, iron, and copper stores for the telegraphic service in the forthcoming year.

Karlsruhe.—Tenders will be received on January 2 next for an electric lighting installation for the railway station and pier at Constance for the Grand Ducal Railway Authorities. Particulars are obtainable for 10 marks (10s.) from the Generaldirektion, (Centralbureau) Grossh. Badischen, Staatseisenbahnen, Karlsruhe, Germany.

Wakefield.—The Visiting Committee of the County Council invite tenders for the maintenance and renewal of the electrical recording stations, signals, bells, and telephones at the West Riding Asylum Wakefield. For further particulars, form of tender, and instructions apply to Mr. J. S. Banks, clerk of works. Sealed tenders, properly endorsed, to be forwarded to Mr. J. Vickers Edwards, county surveyor, Wakefield, by December 14.

Colwyn Bay.—The Urban District Council invite plans, particulars, and estimates, etc., for a scheme of electric lighting for their district, the powers for which they obtained last session. To the author of the scheme considered the best a premium of £30 will be paid, and in the event of the work being carried out such premium must be considered as part payment of the engineer's commission. To the author of the scheme considered second best a premium of £20 will be paid. Further information will be received on personal application to Mr. Wm. Jones, A.M.I C.E., the Council's surveyor. The schemes must be sent in not later than January 12, 1897. Further particulars are contained in an advertisement in another part of the paper.

RESULTS OF TENDERS.

London.—The London School Board have accepted the offer of Messrs. J. Amos and Son to purchase a 60-ampere battery for £20.

Schneidemuhl (Germany).—For the supply of iron lattice telegraph masts for block signalling on the State Railways at Schneidemuhl on November 5, 15 firms from various parts of Germany, tendered at prices ranging from 412 marks to 178 marks according to conditions.

Cardiff.—The Corporation have accepted the following tender for the supply of steam coal for the electric lighting station during half year ending June 30, 1897: Park Coal Company, Cardiff, North Navigation 6ft. vein washed pea nuts 7s. 8d. per ton delivered at G.W.R. siding, 7s. 2d. delivered at Corporation siding.

BUSINESS NOTES.

Personal.—Mr. Gilbert Lloyd, electrical engineer, has taken offices at 60, Broad-street, Bristol.

Central School of Arts and Crafts.—The new premises in Regent-street are lighted throughout by electricity.

Rathmines.—At a meeting of ratepayers the resolution approving of the proposed tramways was lost. A poll is to be taken.

Another Motor Company. — The English Serpollet Motor Syndicate, Limited, has been registered with a capital of £100,000 in £1 shares.

Ealing.—The Electric Lighting Committee reported at the District Council meeting that the number of 8-c.p. lamps now applied for was 9,344.

Graylingwell.—The West Sussex County Council are going to convert the farmhouse into an asylum and extend the electric light to it, at a cost of £200.

Walsall.—The electric lighting of the shops between the bridge and St. Matthew's Church is regarded as a great improvement, and is giving every satisfaction.

Electric Railway Cricket Club.—To celebrate this club's 1895 season a dinner and concert was held at The Horns, Kennington. About 70 guests were present. Mr. C. T. Jenkins presided.

The London Tramways Scheme.—The Finance Committee reported at the London County Council meeting that they found it impossible to bring up their report on this subject before the 8th inst.

Hoyland.—On the question of lighting the township by electricity, the Urban District Council have agreed to engage Mr. Hammond to get up a report and submit to them as soon as convenient.

Preston.—The electric lighting of the town is not giving universal satisfaction judging from the remarks at the Town Council meeting, but the matter is receiving the attention of the Lighting Committee.

Poole.—The Board of Guardians have given consent to the Assessment Committee to appear as respondents in the Bournemouth District Electric Light Company's appeal against rates in the Wimborne division.

Chelsea.—The Vestry have instructed the surveyor to include in his report on street-lighting a statement of the cost of lighting Oakley street with electricity by way of an experiment, using, if possible, the present standards.

Fenton.—The Urban District Council have approved the design submitted by Mr. Sellon of the pole proposed for working the tramways by electricity, subject to its being generally adopted by the other authorities concerned.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended November 29 amounted to £1,148, as compared with £1,020 in the corresponding week of the previous year, being an increase of £128.

Explosion in France.—A serious boiler explosion occurred at an electric-light carbon factory at Nanterre on Tuesday. The building was completely destroyed, and four persons were killed. The damage is estimated at £18,000.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ended November 27 were £1,917. 4s. 7d., compared with £1 677 17s. 7d. for the corresponding period of last year, being an increase of £239. 7s.

Nottingham.—At the meeting of the Town Council next Monday the expediency of promoting a Bill empowering the Corporation to work tramways by animal power, electricity, steam, or any mechanical power will be discussed.

Kensington.—It was reported at the Vestry meeting that, during the month of September, 21 miles 1,480 yards of overhead wires and 430 yards cable (containing 104 wires) were fixed, 915 yards wire had been removed, and two poles renewed.

Windermere.—The Urban District Council have agreed that the 18 electric lamps on the road to Troutbeck Bridge shall be lighted an hour before sunset and extinguished at 10.45 p.m., and not to be lighted at all when there was sufficient moonlight.

Flamborough. — At the Rural District Council meeting a communication with respect to the projected electric light railway, was referred to a special committee of the Flamborough councillors with Colonel Lloyd-Greame and the chairman.

Catalogue.—We have received a most useful and copiously illustrated catalogue from Messrs. Carrick and Ritchie, hydraulic engineers, Edinburgh, of their improved turbines and other water motors for the utilisation of water for electricity and other power.

Kirkby Stephen.—The North-Eastern Railway Company are about to introduce the electric light at the station. The requisite power will be derived from a turbine in the bed of the River Eden, and it is thought that the company may also pump water from the river.

Chelmsford.—The Lighting Committee reported at the Town Council meeting that they could not recommend the Council to light Crane court, as suggested by the Rev. H. A. Lake (rector of Chelmsford), as the court was a private road. The report was adopted.

East Stow.—The Rural District Council propose to put down machinery for the water supply, and it is stated that it is possible

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to have an electric current from Stowupland, which would obviate the necessity of having an engine or a man, the expense of the current being £5 or £6 a year.

Holborn.—At the meeting of the Board of Works the application of the Charing Cross and Strand Electricity Supply Corporation for consent to a proposed provisional order for supply of electric energy to that part of the Holborn district west of Gray's-inn-road was sent to the Works Committee.

Waterloo and City Railway.—It is stated that next year must be very considerably advanced before the first practicable car will find itself in a position to navigate either tunnel, but it may be reasonably hoped that the closing months of 1897 will see the Waterloo and City in full operation.

City and South London Railway.—The returns for the week ended November 29 were £1,054, compared with £988 for the corresponding period of last year, being an increase of £66. The total receipts for the half-year 1896 were £20,895, compared with £19,549 last year, being an increase of £1,346.

Kirkby-in-Ashfield.—The question of lighting the parish with electricity was discussed at the District Council meeting, and the Chairman stated that from information he had it would cost £12,000. The clerk was eventually instructed to ask Mr. Furse, of Nottingham, for a rough estimate.

Gorton.—The Urban District Council have decided to oppose any extension of electric lighting in the Council's district by the Manchester Corporation, and to take action with Denton and other authorities with the object of obtaining a reduction in the price of gas charged by the Corporation to the out townships.

Electrical Railway Signalling.—The *Railway Supplies Journal* gives an account of a new signalling apparatus invented by Mr. Thomas Ainsley, of Durham, and Mr. Michael Watson of Newcastle. When danger is signalled the train makes a contact and sounds a gong, giving audible warning to the driver or guard.

Lancaster.—Mr, Councillor Hall is the chairman of the Electricity Committee for the ensuing year, and Mr. Councillor Jackson is the chairman of the Lighting Committee. The mains are to be extended along Balmoral-road to St. Peter's new schools; and China-lane and Church-street are also to be lighted with arc lamps

The Newcastle Exhibition.—In connection with the proposed electrical and engineering exhibition to be held early next year on the Pandon Dene area, Northumberland-road, Newcastle, the date of opening has been fixed for February 8 next, and the exhibition will on that day be opened with ceremony by the Mayor.

London Lighting Extensions.—The London County Council have sanctioned notices of extensions from the Charing Cross and Strand Electricity Supply Corporation, the Notting Hill Electric Lighting Company, the County of London and Brush Provincial Electric Lighting Company, and the Metropolitan Electric Supply Company.

Rottingdean and Ovingdean and District Electric Lighting Company.—This Company have published notice of their intention to apply to the Board of Trade for a provisional order to supply electricity in the townships of Rottingdean, Ovingdean, and Woodendean, within the district of the Rural District Council of Newhaven Union.

Bradford.—A destructive fire occurred last week in Forster-square, in a huge triangular building occupied by several large firms. The block is directly opposite the General Post Office, and is seven storeys high. The damage is estimated at £100,000. The fire destroyed a large number of Government telephone wires and American cables to the General Post Office.

Commercial Cable Company.—This Company have declared a quarterly dividend of 1¾ per cent. on the capital stock and a bonus of 1 per cent. payable January 1. A special meeting of the shareholders of the Company is called for December 22 at the Company's offices in New York. The transfer books will be closed at noon on 26th inst. and reopened on the morning of January 2.

Walton-on-Thames.—The Walton-on-Thames Electric Lighting and Power Company, Limited, have published notice of their application to the Board of Trade to enable them to supply electricity for public and private purposes in the townships of Walton-on-Thames, Hersham, and Oatlands, in the district of the Urban District Council of Walton-on-Thames, and other purposes.

Anglo-American Telegraph Company. — The Marquis of Tweeddale and Sir Albert J. Leppoc Cappel, K.C.I.E., have retired from the direction of the Anglo-American Telegraph Company, and Sir Gerald Fitzgerald, K.C.M.G., and Mr. Robert A. Benson have been elected to fill the vacancies on the Board thereby created. Mr. F. A. Bevan has been elected chairman of the Board.

Telegraph Extension in the Highlands.—The Postmaster General, by a letter dated 23rd ult., has informed Mr. J. G. Weir, M.P., "that the post office at Stockinish will be opened for the transaction of telegraph business on the 25th inst." This completes the five telegraph extensions effected out of the £1,000 grant in the current vote for telegraph extensions in the Highlands and Islands.

St. Helens.—The Corporation will shortly have completed the laying of the electric light mains in the streets. The plant has cost £10,000, and the Corporation will charge 6d. per unit to begin with. The whole of the plant has been laid down under the superintendence of Mr. Samuel Glover, the manager of the gas and lighting department, and Mr. Robert Hammond is the consulting electrical engineer.

Dewsbury.—At the meeting of the Town Council, a letter was read from the secretary to the Electric Lighting Extension Syndicate asking whether the Corporation would enter into an agreement for the supply of electric energy to the syndicate, such energy to be distributed by them through penny-in-the-slot meters. The application was not entertained.

Glasgow.—Mr. Primrose, in moving the approval of the minutes of the Watching and Lighting Committee at the meeting of the Police Department, called attention to the number of fires reported as having occurred during the month from defective electric lighting installation. It would be desirable, on the threshold probably of the enlarged use of electricity, that attention should be given to the perfectness of installation.

Appointment Vacant.—The Corporation of Derby are advertising in our columns for an assistant engineer at the electricity works. Salary commencing at £3. 3s. per week. Applications, stating age, with not less than two recent testimonials, marked "Assistant Engineer," to be addressed to Mr. J. E. Stewart, engineer and manager, Derby Corporation Electricity Works, Sowter road, Derby, by Saturday, December 12, 1896.

Electric Tramways in the United Kingdom.—At present the electric tramways and railways in the United Kingdom aggregate, says the *Railway World*, a track length of 173·25 miles. Without exception each of the undertakings is proving a success, and experience proves conclusively that there is no reason why electric traction, as soon as the public see the facts as they actually are, should not prove as great a boon in Britain as it is in America.

An Omission.—In the description which appeared in our last issue of the electric light installation at the Guardian Assurance Company's new building we accidentally omitted one important fact The whole of the desk fittings illustrated as Fig. 1 and of the wall brackets to match were manufactured and supplied by Messrs. J. W. Singer and Sons, of Frome, Somerset. These fittings are most satisfactory, both as regards finish and general design.

Municipal Electricity Exhibition at Bradford.—The Mayor of Bradford (Mr. T. Speight) on Wednesday opened an exhibition of electrical plant, motors, cooking and lighting apparatus, etc., at the Swan-arcade, Bradford. The exhibition has been promoted by the Corporation, and its object is to show what developments have taken place in the science of electricity, and more particularly to do something in the direction of popularising the use of the current for motive power.

Swindon.—At the quarterly meeting of the Wilts Standing Joint Committee the Accounts Committee recommended that the agreement with the National Telephone Company for connecting the Swindon police stations by telephone should be accepted. The agreement was to provide two instruments and keep them in working order for the sum of £6. 10s. per annum for a term of five years. The agreement was accepted, and the clerk was given power to take the necessary steps for completing it.

Greenwich.—At the meeting of the District Board of Works Mr. R. S. Jackson moved that it be referred to the Greenwich Committee to consider the application by the Blackheath and Greenwich District Electric Light Company Limited, for a provisional order to supply electricity, etc., within the parish of Greenwich, and to report to the Board as to the desirableness of making representations to the Board of Trade or bringing before that Board any objection respecting such application. This was carried.

Luton.—A communication was read at the Rural District Council meeting from the National Telephone Company asking the Council to reconsider their decision of charging the company 2s. 6d. per annum for each pole erected along the Green Way to the Totternhoe Lime Kilns. Mr. Taylor (district manager) attended before the Council and explained in detail the position of affairs. Mr. Coles gave notice of motion to rescind the previous resolution of the Council, and that the company be charged a quit rent of 1s. 6d. per pole.

Hull.—At the Town Council meeting Mr. Skinner said that, in the hope that the electric lighting extension scheme would be adopted at the next meeting of the Town Council, he thought, in order to facilitate the carrying out of the scheme, they might forestall the Council by appointing some committees to make enquiries They had lost very much time, and it would seriously militate against the pecuniary results at the end of the year. A committee was chosen to make enquiries as to types of machinery, and another to report as to sites for sub-stations.

Hammersmith.—A letter was read at the Vestry meeting from the Metropolitan District Railway Company, stating that the proposed sub-electric railway, if constructed, will emerge to the surface at Earl's Court, with the intention of making it possible for trains to and from places beyond that station to be worked *viâ* the new line; and that with this information before them the Vestry will probably consider it unnecessary to further press their desire upon the directors for a deputation to wait upon them. The Vestry decided to acknowledge this communication.

Bray (co. Wicklow). — The Electric Tramways Company, Limited, have given notice of their intention to apply to the Lord-Lieutenant in Council, through the Bray Township Commissioners, at the time of the next spring assizes, for an Order in Council to authorise the construction and maintenance of various tramway lines in the township of Bray, the townlands of Bray Commons, Ravenswell, and Cork Great. The gauge of all tramways is intended to be 3ft. 6in. It is proposed to use electricity as the motive power, but other mechanical or animal power will be authorised.

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Tonbridge.—The Urban District Council have given notice of their intention to apply to the Board of Trade for an electric lighting provisional order. The following are the names of the streets in which it is proposed that electric lines should be laid laid down within a specified time—namely, Quarry-hill from the corner of Brook-street to the Railway Bridge, the Railway Bridge, High-street, London-road from High-street to west end of Dry-hill Park-road, Shipbourne-road from High-street to east end of Dry-hill Park-road, Dry-hill-road, Dry-hill Park-crescent, and Dry-hill Park-road.

Pembroke.—At the meeting of the Town Commissioners a letter was read from the Rathmines Commissioners expressing regret at the conclusion arrived at by the Pembroke Commissioners in reference to the right of the people of Rathmines township to obtain a tramline to Ballsbridge and the sea. The letter stated that the Rathmines Commissioners were willing to carry out the construction of the line in any way that would meet the approval of the Pembroke Board, and on such terms as to user as would be reasonable. Mr. Vernon said it might be better to wait and see what they did at that day's meeting.

Newington, S.E.—At the meeting of the Vestry, Mr. Chandler moved that the Baths Commissioners be requested to ascertain whether the firm to whom the contract for the installation of electric light to the baths and wash-houses had been given paid trade union wages and observed the trade union hours of labour. Mr. Newman seconded the motion, which was carried. The Clerk said he intended at some future meeting to ask the Vestry to have the installation at the baths carried out under the supervision of their own special expert. Otherwise they might get an installation which would upset their larger scheme.

Wakefield.—At the meeting of the Board of Guardians, Mr. Hall stated, in regard to the electric lighting of the proposed new infirmary, that it would have been very desirable to have handed over that part of the work to the Corporation, but unfortunately they could do it themselves at less than half the cost, and therefore they would not be justified, however anxious they might be as to the success of the Corporation's scheme, in asking them to supply the electric light when they could supply themselves at a much cheaper rate. It was a very singular thing that the Corporation asked 6d. per unit, whereas they could provide the light for 2d. per unit.

Cheltenham.—Notification is given of an intended application to the Light Railway Commissioners for an order authorising the construction of a light railway from the Midland Station, Cheltenham, to the village of Winchcombe. It is stated that the proposed gauge of the line will not exceed 4ft. 8½in., and that "electricity, air, and other motive power," as may be agreed with the Corporation, will be used. At the meeting of the Town Council Alderman Drew gave notice of a motion for the rescinding of minutes allowing the gauge of the proposed electric tramway to be 4ft. 8½in., and of its amendment so as to permit a gauge of 3ft. 6in. only.

Bristol.—The tramway company have just propounded a scheme for the extension of their system to various suburbs of the city, and the general application of electricity as the motive power. The proposals have aroused opposition in some of the districts affected, mainly from the fact that it is intended to introduce the overhead trolley system of electrical traction. At present there are about 16 miles of tramways in the city, which have cost £300,000 to construct, and it is proposed to add 11 miles and relay the old parts at a cost of £400,000. The Corporation, it is expected, will agree to the plan, provided they are allowed to supply the electrical power.

Lanark.—At the meeting of the Middle Ward District Committee of the County Council the Chairman stated, with regard to the lighting of Cambuslang, that the committee thought they would be able to supply electric lighting to that district as cheaply and satisfactorily as gas. The committee were looking into the matter, and therefore were unable to say yet that this would be accomplished. It appeared to them there was no hurry, as nothing could be done this year. They were proceeding cautiously, and were not rushing into the venture without seeing their way clearly. He hoped and believed that electricity would be the future illuminant for Cambuslang.

Plymouth.—Some important experiments took place a few days ago to test the efficiency of a new system of electric search-lights which have been fixed at various points guarding the entrance to the port and dockyard. The six vessels comprising the Devonport torpedo-boat destroyer flotilla proceeded at five o'clock into Plymouth Sound, and returned under cover of darkness through the area defended by the powerful lights. The vessels were clearly seen from the electric light stations, and minute observations of the movements of the flotilla were recorded by the staff of officers of the Royal Artillery and Royal Engineers.

The Copper Trade.—Though the mid-November statistics showed a small increase in the visible stock of the metal, those for the complete month indicate that consumption has once more headed supply. The deliveries for the month reached the high total of 20,915 tons—a figure only once attained before, while the arrivals were 20,253 tons—a record figure. The stocks are consequently 662 tons less than on October 31. The imports from North America to Europe exceeded all previous totals, being 11,458 tons, besides which the 1,024 tons from Spain and Portugal, the 1,950 tons from Chili, and the 1,100 tons from Australia look very small indeed.

Japan.—The application of electricity to practical use has rapidly advanced in Japan, and regulations have been issued by the Minister of State for Communications for the control of the various projects being carried out. The *Indian Engineer* remarks that there is an evident boom in telephones, which are being extended to all parts of the country. In fact, in the matter of telegraphs and telephones it is probable that in some respects Japan is further advanced than Britain. The Japanese have despatched a commission of electrical experts to America for the purpose of studying all the most recent developments in that country, so that they may be utilised in Japan.

Peterborough.—The following resolution was carried at the Town Council meeting: "That it is advisable to convert the premises in Queen-street, purchased for an electric light station, to other purposes of the Corporation, unless within three months a satisfactory application is received from some person or company to acquire the same in order to supply electric light." Last June the Local Government Board decided not to sanction the scheme projected by the Corporation. The premises in Queen-street cost nearly £2,000. Several statements are being made in the town as to firms coming forward to treat for the provisional order, and it is even suggested that the gas company should take it up, but nothing definite has yet been made public.

Dover.—At the Town Council meeting Councillor G. Mowll said the electric light company had erected a new heading to one of the columns in the Market-square. If the Council decided to have it the sooner the better, as it would take at least four weeks to make the lamps for Biggin-street. Alderman Peake remarked that the new lamps hardly seemed to have such big carbons as the old ones. Councillor Mackenzie produced a photograph of the lamps at Portsmouth, which had a couple of incandescent electric lamps on the side, to be used instead of the arc lamps after midnight. He believed that if such a form was approved of in Dover the company would make a substantial reduction from the £30 a lamp. On the suggestion of Councillor G. Mowll, it was decided that the town clerk should forward the photograph to the electric light company, and ask what reduction they would be prepared to allow.

Torquay.—At the Town Council meeting Mr. Kerswill moved the adoption of the Electric Lighting Committee's report on the tenders for the plant required at the electricity works and which tenders we publish in another column. Mr. W. S. Thomas, in seconding, hoped all would now work together to make the installation of the light a success. Mr. Pickard desired to know if it was necessary to spend the whole £20,000 involved in the tenders at the outset? Mr. Glanfield advocated wiring only the compulsory area for the present and leaving the outside districts until there was a demand from them. In reply to Mr. Appleton, it was stated that the works would be complete in nine months. Mr. Shrubb said the whole scheme would be upset if Mr. Glanfield's suggestion were carried out, and the Town Clerk pointed out that the Council had already decided to carry the works beyond the compulsory area. The motion was unanimously carried.

St. Martin's, W.C.—At the meeting of the Vestry a long report was submitted from the Lighting Committee as to the proposed electric lighting of Coventry-street, and their recommendation was agreed to on the condition that the proposed refuge near Oxendon-street should be shifted so as to throw a light down that street, but it would be dangerous to shift the position of the refuge opposite to the Haymarket. It is proposed that the refuges shall be 4ft. in width in the middle, with the guard posts brought out flush with the kerb. The committee stated that they did not think any objection would be raised by the electric companies having powers in the parish to the supplying of electric current by the St. James's and Pall Mall Company, and also that there had been sent a further letter from the St. James's Vestry forwarding copies of letters they had received from the two companies having powers within the parish stating that they did not object to such supply by the St. James's and Pall Mall Company.

Harrow.—The following from the electric lighting company was read at the Urban District Council meeting: "Dear Sir,—The directors considered your letter containing your Council's request to relay the whole top coating of the tar pavement where we break it up in laying our mains. In reply I beg to say that while we are fully aware of an obligation to make good the pavement, we have to the best of our belief done this everywhere, and we do not think we can be fairly be called upon to do more. If your Council wish to have the whole of the top coating relaid, we think that they should bear the cost of relaying the part not touched by our mains. On these terms we shall be happy to relay the whole. (Signed) C. Colbeck, chairman." Mr. Dell said he would like the Legal Committee to consider the point. He could not understand that they could have their footpaths spoiled without having any redress. Mr. Hawkins remarked that the company had their Act of Parliament, and knew what they were about. The matter was then referred to the Legal Committee.

Fulham.—The Electric Lighting and Dust Destructor Committee reported at the Vestry meeting that at their last meeting they had under consideration a scheme from the County of London and Brush Provincial Electric Lighting Company, stating that upon the grant of a provisional order to the Vestry they would be prepared to take a transfer of it upon the terms that the company should pay the costs of the Vestry incurred in obtaining the grant of the order and its transfer, the company undertaking to supply current into Fulham at the earliest moment at a commencing price not exceeding 7d. per unit and agreeing to reduce the price as soon as the demand is sufficient to enable them to do so, and that the company would also agree to give the local authority the right to purchase the undertaking so far as it is within the parish of Fulham any time after seven years from the commencement of the order at a price to be determined by arbitration under the Lands

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Clauses Act. At present the committee were not prepared to recommend that the proposal be entertained.

New Metropolitan Electric Railways.—The new schemes for electric railways in the Metropolis include the "City and West-end," a project for a line from Hammersmith to Cannon-street. Another is called the "Brompton and Piccadilly circus," and a third is called the "West Suburban," being for a line from Praed-street to Willesden. Two of the electric lines sanctioned some years ago give notice of applying for extension of time to complete works. One of these is the Great Northern and City, sanctioned under its Acts of 1892 and 1895. The other is the Charing Cross, Euston, and Hampstead, which seeks to revive powers granted by its Acts of 1893 and 1895. It also intends to change its name. The Central London, now in course of construction, gives notice of a Bill for minor alterations of the original scheme. The London, Walthamstow, and Epping Forest publishes two notices. One is for the abandonment of the line and the release of the parliamentary deposit. The other is for extension of time for completion of works granted under its Acts of 1894 and 1895.

Allgemeine Elektricitats-Gesellschaft.—The Electrical Company, Limited, of Charing Cross-road, have sent us a copy of the annual report to June 30 last of their parent company—the Allgemeine Elektricitäts-Gesellschaft, of Berlin—which will go before the general meeting on December 5. The report refers to the enlargement of the company's capital and the new works. About 4,000 dynamos and motors have been turned out in the past year; these have an aggregate output of 74,000 h.p. The incandescent lamp trade has also improved, the increase in the output over the previous year amounting to 600,000 lamps. The company has now equipped 34 electric tramways, employing some 918 cars. From the report one quickly sees the advantage the firm has gained from a strong financial support, enabling to provide, in many cases, capital, as well as the necessary electrical apparatus. The accounts show gross profit of about £230,000 for the year, which, after providing liberally for depreciation, reserve fund, and other sundry items, allows a dividend of 13 per cent. on a capital of £1,100,000. We also note that the various valuable patents owned by this firm stand as an asset in the statements to the extent of 1s. only.

Telephone Communication.—At the Liverpool Chamber of Commerce, Mr. Bindloss said they had been in communication with the Post Office authorities on the question of trunk telephone communication, and he was pleased to be able to announce that they had got an extension of time from three to six minutes without any intermediate cutting off. The Chamber had also, in communication with other bodies, been able to effect a serious reduction in the cable rates to the East. The rate to Japan by the northern route was to be reduced from 8s. a word to 6s. 2d., and the Eastern Extension Telegraph Company also intended to make a reduction on the rate to Japan *viâ* Hong-Kong from 10s. 8d. to 8s. 6d. a word, but unfortunately that was not to take place for some time. The Eastern Telegraph Company had also notified these reductions to the far East to take effect on January 1: Malacca and Native States, to 5s. from 5s 7d; Singapore, to 5s. from 5s. 9d.; Labuan, to 5s. from 6s. 5d.; Java, to 5s. from 6s.; other islands of the Dutch Indies, to 5s. 5s. from 6s. 6d.; Cochin China, to 4s. 6d. from 5s 1d.; Annam, to 5s. 3d. from 5s. 10d.; Tonkin, to 5s. 6d. from 6s. 3d.; Siam (*viâ* Singapore), to 5s. from 5s. 7d.; Seychelles (*viâ* Suez and Aden), to 5s. from 7s. 3d; Mauritius, to 5s. from 8s. 9d.

Stoke.—The Town Council have approved the design of pole submitted by the British Pioneer Company, Limited, for erection in the streets for the purpose of electric traction equipment, subject to an alteration in base made by the borough surveyor. The report of the Tramway Sub-Committee was adopted at the last meeting. This stated that the town clerk laid before the committee the notice of proposed transfer of the undertaking from the old promoters to the British Electric Pioneer Company, Limited, and also certain correspondence between local authorities and parliamentary agents, and after discussion it was resolved that the town clerk having informed the committee that formal notice of objection to the proposed transfer had been lodged, and after reading the correspondence between the local town clerks and parliamentary agents, and also a letter from the latter, saying that the solicitor to the promoters had called upon them and asked them to withdraw the notice, as it was very urgent, and also in view of the instruction of Council to combine with other towns in joint action, and such other towns having given their consent to the proposed transfer, "That the sanction of this Corporation be given to the proposed transfer forthwith, and that the town clerk be instructed to advise the parliamentary agents to withdraw the objections at once."

Bromley.—The General Purposes Committee reported at the Urban District Council meeting that with regard to the question of the electric lighting provisional order they regretted that owing to the absence of two members they were unable to obtain a full committee meeting, and under the circumstances would suggest to the Council that the question be referred to a special committee, which should be appointed at the present meeting. The Chairman, in moving the adoption of the report, said it was desirable—the provisional order being a matter of very great importance—that the committee should be strengthened, and he would like to move the addition of one or two members to the committee in order that the matter might be thoroughly dealt with. Mr. Mallett seconded. The subject of the electric lighting of Bromley was of the greatest importance, and should be dealt with by the strongest committee possible. Eventually the matter was referred to the whole Council in committee. Messrs. Waterer and Dickins wrote: "Electric lighting.—We beg to advise you that as nothing now remains in dealing with the transfer of the provisional order but the settlement of the conditions to be sanctioned by the Board of Trade, giving the Council powers to purchase the works, we have handed over the matter to Messrs. Edmundsons, who will act as engineers to the company, and to whom you will please communicate in future."

Edinburgh.—At the City Council meeting the Electric Lighting Committee submitted the report of the chief electrical engineer on the condition of the plant and mains and the working of the electric lighting station for the half year ending October 15. Mr. Mackenzie moved that the Council suspend the standing orders, and remit to the Electric Lighting Committee to procure the new machinery necessary for next year. They commenced the electric lighting on April 11, 1895, with 48 customers, and they had 2,200 lamps connected with it. The number of customers on May 15 this year was 452, and the number of lamps connected at that date was 58,600. Since then the number of consumers had been increased to 732, and the number of lamps connected with the system was now 82 830, with 6,290 more lamps applied for, so that they would soon have 90,000 lamps. The number of units sold from May 15 to November 26 last year was 308,280, as compared with 605,126 units for the corresponding period of this year. As far back as February of last year they had ordered six engines and dynamos and a number of boilers. The boilers were in position, but they had not been able yet to get the whole of the engines. It was proposed to spend about £15,000 on new machinery. He hoped the Council would be able to reduce the charge for electric lighting from 5d. to 4d. per unit, and from £18 to £16 per lamp. The motion was agreed to.

British Motor Syndicate.—The prospectus of the British Motor Syndicate, Limited, has been issued. The registered capital is £1,000,000 in £1 shares, and the present price is £3, payable 10s on application, £1. 10s. on allotment, and £1 one month after allotment. The shares are issued fully paid to the original inventors and patentees and their nominees controlling their interests in future improvements. The prospectus states that the proposals to buy from the syndicate licenses to form companies to build motorcars under their master patents, and the purchase-moneys to be paid to the syndicate in connection therewith, now exceed £800,000, which, being profit, are divisible upon completion amongst the shareholders. The prospectus has been the subject of much correspondence in the daily papers. Mr Henry Holt wrote to say that he gave no authority for the use of his name. Mr. Radcliffe Ward points out that the London Electric Omnibus Company's patents do not belong to the syndicate (the prospectus stated that the syndicate had a monopoly of the best patents); Mr. Frederic Prince also condemned the "ridiculous statement" that the syndicate possessed all the master patents; Mr. Robert Wilson (London manager) points out that the reference to Crossley Bros., Limited, in the prospectus was entirely unauthorised; the publisher of the *Engineer* says the reference to that journal was unauthorised; and Mr. Worby Beaumont says his name was unauthorised, and that he has no interest of any kind in the syndicate or any other similar business.

Leatherhead.—At the meeting of the Urban District Council the Clerk said he observed in the papers that application had been made to the Board of Trade by the Leatherhead Electric Lighting and Power Company for authority to supply electricity for public and private purposes in the district, in which they stated that they would lodge plans by December 21, and that every local or other public authority was entitled to lodge any objection or make any representation before January 15. He had received a letter from the secretary to the Leatherhead Gas Company stating that he was desired by his directors to inform the Council (in view of the recent notification respecting the formation of an electric lighting company) that they were engaged in the reconstruction of their company with the view of incorporating powers of lighting by electricity or by any other later illuminating invention. As it must be evident that they would have greater facilities and means for carrying out economically any better system of lighting that might be desired, they respectfully asked for such assistance in the matter as the Council could give. Mr. Howell said they ought to be satisfied with the standing and financial position of any electric lighting company. The Chairman said it would be very awkward if the company broke up the roads and had not the money to repair them. The Clerk suggested that application should be made to the Board of Trade for the right of pre-emption; that was, that the Council should after, say, 14 years from the time of installation have the right to buy up the company at a valuation. In reply to Mr. Heaver, the Clerk said that over and over again companies had transferred their powers to others. Dr. Davis said by the Electric Lighting Act the Council could consent or not. On the motion of Mr. Dearle, seconded by Mr. Howell, the clerk was directed to obtain a copy of the draft order, it being pointed out that the gas company would not now apply for an order until another year.

London.—At the meeting of the Commissioners of Sewers the Streets Committee presented a report relative to the expiration, at Christmas next, of the agreement in respect of the premises in the Wool Exchange, Basinghall-street, temporarily used as an electrical laboratory, and recommended that the tenancy be renewed for another year at a rental of £170. The report was agreed to. Mr. Gordon asked if the chairman of the Streets Committee would shortly issue a report on the subject of the private lighting, in consequence of the complaints which had been made by consumers. Almost everyone who had used the electric light had experienced, he said, great inconvenience, because of the frequent failures of the light. If the Commission had no control over the private lighting the Court should state so, and the consumers would then

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know the position in which they were placed. Mr. Hudson said he was not prepared to make a statement in regard to the private supply, but he hoped the question of lighting the minor streets would soon be settled. Mr. Gordon then asked permission to question the electrical engineer (Mr. Voysey). Mr. Voysey said he would prefer to have time to consider that question, and answer it on another occasion. He was not aware that there had been any large number of complaints in regard to the private lighting—at least, they had not reached him. The consumers had the right to apply to him if the pressure of the current was unsatisfactory. Mr. Gordon, with permission, moved that the question should be referred to the electrical engineer with instructions to report. The Chairman said the solicitor held that the Commission had no control of the private lighting Mr. Gordon then moved that the subject should be referred to the Streets Committee to consider and report upon the remedies which the private consumers had at hand. Mr. Morton, in seconding the motion, said he hoped the private consumers would address their complaints to the Court, so that there would be no doubt as to whether they were satisfied or not. The motion was then adopted.

Wrexham.—The minutes of the Lighting Committee, read at the Town Council meeting, stated that the town clerk had received the following letter from the Rural District Council: "'Dear Sir,—Your letter of the 28th ult. was considered at a meeting of the District Council held on the 5th inst., and I was instructed to inform you that the Council object to the proposal to include in the powers of the provisional order, for which the Town Council are about to apply, the portions of Stansty and Broughton lying within the parliamentary borough of Wrexham. and the townships of Bersham. Erddig, Abenbury, and Acton.– Yours faithfully, J Oswell Bury, clerk.' Upon the above intimation, and as to the steps to be taken in proceeding with the application for a provisional order, limited to the municipal borough, he had seen the parliamentary agents (Messrs. Sharpe, Parker, and Co.), at Westminster, on the 6th inst., with instructions, and he now submitted a proof, forwarded by them, of the *Gazette* notice of intention to apply to the Board of Trade on or before December 21 next for a provisional order under the Electric Lighting Acts, 1882 and 1883. The further requirements of the Board of Trade, as to deposits, plans, copies of proposed order, etc., as stated in a letter dated the 9th inst. from the parliamentary agents, were laid before the committee It was recommended, on the motion of the Chairman, seconded by Mr. Pierce, that the print of the *Gazette* be approved, and that the Bridge-street compulsory area be limited, as mentioned in the draft notice, to that part lying between Brook-street and Bryn Issa. It was also recommended, on the motion of the Chairman, seconded by the ex-Mayor, that the notice be advertised on the 21st and 28th inst. in the local newspapers, and that the parliamentary agents and the town clerk take all such further steps as may be advised for obtaining the order for the borough." Mr. Palin moved, and Mr. Benson seconded, the adoption of the minutes. Mr. Thomas Jones asked if they had abandoned the intention of applying for power to go into the rural districts. The Town Clerk said that was so He had written to the clerk of the Rural District Council enquiring the grounds for objection, and he had replied that the grounds of objection were not stated in the resolution. The minutes were adopted.

Dudley.—At the Town Council meeting, Alderman G. Bagott proposed the adoption of the General Purposes Committee's report, which stated that Mr. Sellon, the engineer, and Mr. Millard, the solicitor, of the company which proposed to take over the tramways in the South Staffordshire district, had again attended for the purpose of giving further explanations, and after discussing the matter they decided to hold a special meeting to consider the whole question, and recommended that they be an executive committee to give consent to enter into all arrangements with the proposed company, such arrangements to be reported to the Council. Alderman Bagott remarked that he was glad to know that the necessary documents with regard to the proposed improved tramways in the district had been lodged with the Board of Trade. He ventured to say, as the result of the experience he had had in tramway work, that the proposed scheme was a grand one, and more especially for that borough, because Dudley would be the centre of almost all the tramways in the Black Country. When they considered that one tramway company — the Dudley and Stourbridge — carried something like 2,000,000 passengers in the course of the year, they might naturally expect that if they got all the proposed branch tramways running into the town it would represent a large addition to the trade and prosperity of the borough. Mr. Messiter said that the tramways scheme was a very important one and involved serious questions, including that of the introduction of the electric light into the borough, and for that reason he did not think it was advisable for the Council to give their sanction to the General Purposes Committee being an executive body in the matter, and moved as an amendment that the paragraph containing the recommendation be excluded. Mr. J. Hughes said that nothing tangible had yet been brought before the committee, and, as every vital point in the scheme would have to be discussed by the Council, he saw no objection to the recommendation. The Town Clerk (Mr. Warmington) said that two or three months would elapse before they were in possession of all the facts relating to the scheme, and it was quite certain, that so far as consent to it was concerned, it would have to begiven by the whole Council. After some further discussion, Alderman Bagott consented to the withdrawal of the paragraph containing the recommendation.

Newcastle.—The members of the City Lighting Committee, headed by the Mayor (Mr. John Goolden), the Sheriff (Mr. Beattie), and the chairman of the committee (Alderman J. Baxter-Ellis), visited Edinburgh on Monday. At the Royal Hotel, in Princes-street, they were entertained to luncheon by Councillor Gillespie, of Newcastle. The company were joined by the Lord Provost, the chairman of the Electric Lighting Committee of Edinburgh, and others After luncheon, the Mayor of Newcastle proposed the health of the Lord Provost, and other members of Edinburgh Corporation present. In the course of his remarks, he said the members of the City Lighting Committee of Newcastle had come to seek information respecting the electric lighting of Edinburgh. From what they had heard, they understood Edinburgh was far ahead of any other city in the kingdom with regard to electric lighting. The Lord Provost, in response, said he would be pleased to give the deputation all the information in his power regarding the city he had the honour to represent. The electric lighting was in the hands of the Corporation; also the gas. It was only recently they had gone in for lighting the streets by electricity; each large lamp entailing a cost to the Corporation of about £22 a year. The capital expenditure up to the present time was, roughly speaking, about £250,000, and the Corporation found it a lucrative investment, as well as a great convenience to the inhabitants of Edinburgh. The most satisfactory part was that it did not in any way diminish the consumption of gas, which was still on the increase. The Chairman of the Lighting Committee of Edinburgh also responded, after which the deputation proceeded to survey the electricity works, and also viewed the lighting of the streets. General surprise and satisfaction was expressed at what was witnessed. Full notes were taken by Mr Lawson, committee clerk of the Corporation, and also by Mr. Lamb, lamp inspector, and an exhaustive report will be presented to the Town Council. Reference was made to the shadows cast from lamps in Newcastle on the ground, whilst in Edinburgh this was obviated by changing the form of the lamps. It was also stated that the cost of each large lamp in Newcastle was about £42, and the general feeling seemed to be that the Newcastle Corporation should take the whole matter into their own hands, buy out the present companies, and supply the electric lighting themselves.

Brighton.—Electricity mains are to be laid in Southdown-avenue and Wakefield-road. The report of the Works Committee presented at yesterday's meeting of the Town Council contained the following: "A letter was read from Sir R. Hunter, solicitor to the Post Office, with further reference to the application of the Postmaster-General for permission to erect a line of overhead telegraph wires across Stanford-road to the Exeter-street Post Office, and a line of overhead wires in Ditchling-road, and applying for the consent of the Corporation to the carrying of an overhead line of wires on the railway over New England-road, Preston-road, and Beaconsfield-road and to the erection of posts in the public highway in a portion of Ditchling-road for the purpose of carrying a line of telegraph wires overhead. It was resolved that Sir Robert Hunter be informed that the committee are unable to recommend the Council to consent to the erection of any telegraph posts on the public highways in the borough. At another meeting on November 27 the committee again considered the letter from the solicitor to the Post Office on the subject of overhead telegraph wires, suggesting the alternative route put forward by the local engineering staff in September last. The committee passed the following resolutions: 'That the Council hereby consent to the erection of a line of overhead telegraphs across New England-road, Preston-road, and Beaconsfield-road, on the understanding that the Postmaster General is to make good any damage which may be done in the execution or maintenance of the work, and that it will not be necessary to erect any poles in the roads; that the Council will consent to the erection of an overhead telegraph line along the Ditchling-road from a point on the bridge carrying the said road over the Lewes branch railway line to the boundary of the borough, on condition that no poles for the purpose of carrying such telegraph line shall be placed upon the highway, except upon such portions thereof as are not enclosed by land occupied with buildings, and that any poles which may be erected on the highway shall be of such design and placed in such positions as shall be approved by the borough surveyor and subject to the further condition that the Postmaster-General will undertake to remove any pole or poles on the highway upon receiving notice from the Corporation so to do, such notice not to be given by the Corporation until, in their opinion, the erection of houses on the land abutting upon Ditchling-road renders the removal of such poles necessary.'"

Poplar.—At the meeting of the District Board of Works the clerk read the following letter from Mr. Sydney Morse, of 4, Fenchurch-avenue: "Dear Sir,—Referring to the notice served upon you in June last on behalf of the County of London and Brush Provincial Electric Lighting Company, Limited, I am now instructed to write and ask for formal consent of the Board of Works to the grant of a provisional order to my clients. I am instructed to add that my clients are prepared on condition of this consent being given to pay the costs incurred by the Board in obtaining their provisional order. It may be of importance to your Board to know that my clients will be prepared if the order is granted to them to supply electricity to private consumers for electric lighting at a commencing price of 7d. per unit, and for power purposes at 5d. per unit. They would also be prepared, if agreeable to the District Board, to make a contract for the supply of electricity for public lighting, provided a contract were made for a minimum of 10 all-night lamps on the basis of 3½d. per unit. We propose to include in our provisional order as compulsory area the streets comprised in schedule 2 of the order granted to your

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Board. I shall be pleased to give any further information that may be required." Mr. Carpenter moved, and it was seconded, that the writer be informed that the Board intended doing its own electric lighting. Mr. Stephens said it seemed to him the Board were acting the part of a dog in the manger—they would not do it themselves or let anyone else. He moved the reference of the letter to the Works Committee. Mr. Dalton seconded that, and thought it was time the Board gave some definite opinion on the matter. For the past three or four years they had been standing in the way of anyone else coming into the district, and it was time now, if the Board could not undertake the matter, to give someone else the opportunity of doing it. Mr. Bussey said there had been delays, one of which was caused by the Board not knowing exactly what the London County Council purposed doing in regard to the lighting of Blackwall Tunnel, but as it was now found the Council would lay down their own installation, that obstacle to a settlement was removed. He felt the Board was in a much better position than any company to deal with the subject, and believed if it were dealt with in a whole-hearted manner, some benefit would accrue to the district. Eventually the matter was referred to the committee to whom had been referred the dust-destructor question.

Leeds.—A conference of representatives of telephone workers from various parts of England has been held at the office of the National Union of Gasworkers and General Labourers, Bond-place. Amongst the districts represented were London, Middlesbrough, Birmingham, Bristol, Lancashire, Leeds, Bradford, Huddersfield, Halifax, Dewsbury, and Hull. The object of the conference was to consider a proposal made by the National Telephone Company to establish a uniform working week of 52½ hours. In Yorkshire the working week is 52 hours, and the result of the adoption of the proposal would, therefore, in the case of Yorkshire workers, be to increase their weekly work by half an hour. On the other hand, the change would be an advantage to a large number of other workers. There is no urgent need for an immediate settlement of the question, as at the present season of the year it is impossible to work a full week, and after further considering the question in its various aspects it was decided to adjourn the conference for three weeks, to allow the delegates to consult their branches on certain points—viz., firstly, if they are prepared to accept 52½ hours per week as the standard if the company will arrange a system whereby the men shall not be called out in winter when it is impossible to work a full day; secondly, if they are prepared to support a movement for payment at the rate of time and a half for all overtime with the exception of Sunday, which is paid for at the rate of double time; and thirdly, that each district may forward in writing a method of dealing with what is known as "wet time." In explanation of these points it may be said that at present the men have to turn out at a regulation time every morning, whether the light permits work to be commenced or not. This leads to time being spent in public-houses which might otherwise be utilised at home, and it is believed that the company will favour any arrangement which will prevent the waste of time now common from this cause. On the question of overtime it may be observed that the men at present receive no extra pay for working at night or on Saturday afternoon. In regard to the third point, it appears that at present, if a man gets wet through in consequence of a storm coming on whilst he is at work, he is not allowed time to change his clothes, and if he goes home to do so it must be at his own expense. It is also the practice, when a storm prevents further work for the day, for the payment to be by the hour up to the time of stopping work, and there is a feeling that work cut short in this way might be counted by quarter or half days. About 4,000 men were represented at the conference.—A boy in the employ of Messrs. Laing, Wharton, and Down, electricians, was carrying a two-gallon bottle of black paint the other day, when from some cause or other it exploded. The boy said he was simply uncorking it, but it scorched his eyebrows and burnt his eyes so that he had to go to a doctor.

Islington.—The following report of the Electric Light Committee will be considered at the meeting of the Vestry to-day: ' On several occasions the committee have considered the question of the advisability of purchasing 44 46, and 48, Eden grove, and 1, Burnard-place, being the only houses abutting upon the electric lighting station site which have not been acquired by the Vestry, and have been in negotiation with the owners of such houses with a view to their purchase. In addition to the freehold interest therein, the four houses are held under a lease for 99 years from Midsummer, 1848, at a ground rent of £21 per annum for the four, which lease is subject to an underlease of 48, Eden-grove, for practically the same term at a ground rent of £6 per annum, which consequently reduces the ground rent of the four to £15. The lessee is now prepared to sell his interest in the houses subject to the underlease, and to give the Vestry vacant possession of 44 and 46, Eden-grove, and 1, Burnard-place, for the sum of £700 and his solicitor's costs according to scale, such offer being a substantial reduction in the price originally asked by him. There is every probability of the Vestry being able to acquire the other interests in the property at a reasonable cost, and in view of the fact that the site of such houses will shortly be required for further extensions to meet the increasing demand for electricity, that some cause of action against the Vestry may possibly accrue by reason of the extension buildings now being erected interfering with the access of light and air to the rear of such houses, and also to the fact that their acquisition will give the Vestry entirely uninterrupted frontages to Eden-grove and Burnard-place, the committee recommend (subject to the Vestry being enabled to acquire the freehold at a reasonable sum and to a good title being shown) that the lessee's offer be accepted and that the Finance Committee be authorised to apply for a loan to cover the purchase-money and costs." At the last meeting of the Vestry it was decided to fit the machine shop at the lighting station with the requisite tools and appliances at a cost of £250. As to the application for a loan of £25,000 for electric lighting purposes, Mr. Dryden said the London County Council seemed to get it into their heads that they were carrying out the electric lighting work. The Vestry were carrying out the work, the work was theirs, the risk was theirs, and they challenged the action of the London County Council. The London County Council had no right to see every detail of expenditure connected with the work. They wanted to come to the Vestry Hall and examine their books and vouchers. His committee denied their right to interfere so far; they resisted this encroachment upon their independence. If they were to submit to that they might as well discharge their officials and employ those of the London County Council. They did not want the assistance of the Council. They did not really want their money, but unfortunately they had to get their sanction to loans. He advised the Vestry to resist the London County Council. Although a sum of £25,000 was applied for, the London County Council agreed to lend £24,000. He recommended that that be accepted. Mr. Lambert seconded, and the motion was carried.

Private Bill Legislation.—The following are among the private Bills to be proceeded with in the ensuing session of Parliament. Plans have already been deposited, and the Bills themselves will be deposited later on. The appended list does not include measures which simply involve money powers, without works, or the transfers of undertakings (such as the London County Council Water Bills). As compared with last year the number of deposits shows an increase of 35, the actual figures being last year: railways 63, tramways 15, miscellaneous 66 provisional orders 77, electric lighting 37—total, 258; this year: railways 68, tramways 19, miscellaneous 60, provisional orders 91, electric light 55—total, 293. *Provisional Orders*: Blackpool Corporation (Tramways); Cardiff Tramways Extensions; Carlisle Tramways; Great Yarmouth and District Tramways; Huddersfield Corporation Tramways; Manchester Carriage and Tramways Company; Manchester Corporation Tramways; Middlesbrough, Stockton-on-Tees, and Thornaby Tramways; Morecambe Urban District Council Tramways; Moss Side Tramways; Penarth Tramways; Perth and District Tramways; Reading Tramways; Withington District Tramways: Yarmouth and Gorleston Tramways. *Railways*: Brompton and Piccadilly-circus Railway; City and West-end Railway; Central London Railway; Watford, Edgware, and London Railway; West Suburban Railway. *Tramways*: Bradford Corporation Tramways Improvement; Bristol Tramways; Birmingham (City of) Tramways; Bolton Tramways and Improvement; Birmingham, Wolverhampton, and District Tramways; Coventry Electric Tramways Extension; Dublin United Tramways (New Lines); Edinburgh Northern Tramways; Halifax Corporation Tramways; Hastings and St. Leonards Tramways; Leeds Corporation (Water, Tramways, and Improvement); Norwich Electric Tramways; North Metropolitan Tramways (No. 1); North Metropolitan Tramways (No. 2); Neath Corporation Tramways; Rathmines and Rathgar Township Tramways Improvement; Sheffield Corporation Street Widening and Tramways; Swansea Corporation Tramways; Weston-super-Mare Pier and Tramways. *Electric Lighting Provisional Orders*: Ambleside; Ballymena; Bangor Corporation; Barking Town; Bermondsey, Rotherhithe, and Newington; Bexhill (two); Blackheath and Greenwich; Brighouse Corporation; Bury St. Edmunds Corporation; County of London (East); County of London (Northern Extensions); Dorking Urban District Council; Droylsden; Darwen Corporation; Dundalk; Dudley Corporation; Denton; Epsom; Farnworth; Fulham (two); Garston; Hoylake and West Kirby; Ipswich Corporation; Kearsley; Llandrindod Wells; Leatherhead; Leith; Levenshulme; Lincoln; London Electric Supply Corporation (Westminster); Morecambe; Morleyside Corporation; Newmarket Urban District Council; Poole and Branksome; Prescot; Redditch Urban District; Reigate Corporation; Rottingdean and District; Ramsbottom; Southampton; Stretford; Swadlincote; Tonbridge; Ventnor; Wallasey Urban District Council; Walton-on-Thames; Wimbledon; Withington; Wrexham Corporation; Watford; Wilmslow Urban District Council.

PROVISIONAL PATENTS, 1896.

NOVEMBER 23.

26427. **Improvements in electrical wires.** Robert Brymer and John Todd, 70, Market-street, Manchester.

26452. **Improvements in electric storage batteries.** Percy Lowe Norrington, Abbotsfield, Mannamead, Plymouth.

26470 **Improvements in electrical reversing switches.** William Thomas Taylor, Bridge House, Staines.

26491. **Improvements in and relating to electric accumulators.** Ippolito Celestre, 322, High Holborn, London. (Complete specification.)

NOVEMBER 24.

26539. **Application of electricity for the thawing off of ice from cells and plates of refrigerating apparatus.** Samuel Taylor Parry, Princess-street, Chester.

26546. **Improvements in motor carriages and the adaptation of same to electrical advertising.** Eugen Sandow and Andrew George Adamson, 154, St. Vincent-street, Glasgow.

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26565. **Electric lighting of bicycles, motor cars, etc.** Ida Marion Sutherst, Alliance Steel Foundry, South Bank, R.S.O.

26583. **Improvements in rail bonds for electric railways.** Vivian Bolton Douglas Cooper, Allan John Lawson, and Stephen Presscott White d'Alte Sellon, 70, Chancery-lane, London.

26597. **Improvements in and connected with joints and junctions for electrical conductors and conduits.** Carrington Riddell Gordon Smythe, 23, Leamington-road-villas, London.

26598. **Improvements in apparatus for preventing accidents by electrical tramcars.** Karl Puskas, 65, Chancery-lane, London.

26627. **Improvements in or relating to alternating-current systems of distribution and regulation.** Reginald Belfield, 322, High Holborn, London. (Benjamin G. Lamme and Ralph D. Mershon, United States.)

26677. **Improvements in electric switches for use in connection with electrically propelled vehicles and locomotives and for other purposes.** Albion Thomas Snell, Charles Edward Grove, and Arnold Frank Hills, 4, South-street, Finsbury, London.

NOVEMBER 25.

26737. **Improvements in and relating to electric batteries.** Hartley Fewson, 75, Landor-road, Stockwell, London.

26742. **Improvements in the construction and manufacture of spring-jack switches used in telephonic switchboards.** Daniel Sinclair and Frederick Alfred Stanley Wormull, Oxford-court, Cannon-street, London.

26774. **Improvements in conduit pipes for electric conductors.** Henry Edmunds, 47, Lincoln's-inn-fields London.

26776. **Improvements in devices for protecting electrical instruments or machinery from the effects of lightning or excessive voltage.** George Kemp and Edward Middlemiss, 45, Southampton-buildings, Chancery-lane, London.

NOVEMBER 26.

26811. **An improved method or means for the conversion of alternating into continuous or unidirectional currents.** Frank Michael Lewis and Bernard Page Scattergood, 30, Park-row, Leeds.

26828. **Improvements in electric accumulators or storage batteries and primary batteries.** John Dalrymple Bell, 121, West George-street, Glasgow.

26846. **Improvements in electric bell pushes or knobs.** Thomas Sanders, 77, Colmore-row, Birmingham.

26864. **An improved continuous-current machine operating by induction.** Max Brab, 70, Chancery-lane, London. (Complete specification.)

NOVEMBER 27.

23942a. **Improvements in electric switches.** Reginald Belfield, 322, High Holborn, London. (Alexander Jay Wurts, United States.) (Date claimed under Patents Rule 19, October 27, 1896.)

26911. **An automatic current and potential regulator.** New and Mayne, Limited, Palace-chambers, Westminster, London.

26947. **Improvements in electrical switches.** Max Byng and Francis George Bell, 73, St. Stephen's-road, Upton Park, London.

26965. **Improvements in means and apparatus for use in electrically lighting incandescent and other gas burners.** Frederick Richard Boardman, 55, Chancery-lane, London.

26969. **Improvements in frames for holding finely-divided mass such as the active material of electric accumulators.** Wilhelm Holzapfel, 433, Strand, London. (Complete specification.)

NOVEMBER 28.

27041. **Improvements in conduits for gas-pipes, electric wires or cables, and other analogous purposes.** William Sayer, Imperial-chambers, Albert-street, Derby.

27047. **Improvements in or connected with electric cable disconnecting boxes.** George Hinde Nisbett and William Boby, 15, Water-street, Liverpool. (Complete specification.)

27048. **An improved combined electric and hydraulic lift.** Percy Richard Julius Wallace, 55, Chancery-lane, London. (John Parkinson, United States.)

27049. **An improved combined electric and hydraulic elevator.** Percy Richard Julius Wallace, 55, Chancery-lane, London. (John Parkinson, United States.)

27053. **A new or improved insulator device for carrying vertical or similarly suspended electric cables.** Roslyn Holiday, 3, Burlington-arcade, Barnsley.

27128. **Improvements in electric tramways and railways.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Riccardo Arno and Aristide Caramagna, Italy.) (Complete specification.)

27131. **Improvements in electrical apparatus for signalling to and from railway trains and locomotives.** Robert Burn, Alfred Charles Brown, and Leonard George Tate, 196, Green-lanes, Finsbury Park, London.

SPECIFICATIONS PUBLISHED.

1895.

18420. **Electrical apparatus for railway signalling.** Daniell.

22142. **Electric battery.** Falle.

22569. **Electric bell pushes.** Creasey and Breach.

22661. **Apparatus for indicating and recording electric supply.** Baron Kelvin.

22712. **Generating steam by means of electricity derived from dynamos driven by the steam generated.** Dunn and Dalrymple.

23097. **Electrical deposition of zinc.** Heathfield and Rawson.

23338. **Electric arc lamps.** Fisher.

23496. **Electric railways.** Belfield.

24471. **Devices for protecting electric circuits and apparatus from injury by excessive electrical potential due to lightning or other cause.** Fynn and Easton, Anderson, and Goolden, Limited.

24868. **Recording instruments for telegraphic and other purposes.** Baron Kelvin.

24888. **Hinges or joints for electrical purposes.** Goldring.

24892. **Regulators for dynamo-electric machines.** P. R. Jackson and Co., Limited, and Lewis.

24895. **Dynamo-electric machines.** P. R. Jackson and Co., Limited, and Lewis.

24949. **Electric arc lamps.** Allin.

1896.

64b. **Electric tramways or railways.** Krizik. (Date applied for under Patents Rule 19, January 1, 1896.)

879. **Electric measuring instruments.** Evershed and Vignoles, Limited, and Evershed.

7065. **Electric hammers and the like.** Lake. (Barnes and Skinner.)

17203. **Methods and means for electric regulation of power.** Gale and Thompson.

20505. **Electrodes for secondary voltaic batteries.** Imray. (Grindle.)

20600. **Electrodes for use in the production of the electric arc.** Deuther.

20601. **Electric furnaces.** Deuther.

20902. **Mechanism for electric arc lamps.** P. R. Jackson and Co., Limited, and Mensing.

21632. **Electric light fittings.** Donovan.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	7¾-8¼
Brush Company, Ordinary	3	⅞-1⅛
—— Non. Cum., 6 per cent. Pref.	2	1-1¼
—— 4½ per cent. Debenture Stock	100	110-113
—— 4½ per cent. 2nd Debenture Stock	100	96-100
Central London Railway, Ordinary	10	9¾-10¼
——	4	3⅞-4⅜
Charing Cross and Strand	5	9½-10
Chelsea Electricity Company	5	8-8½
—— 4½ per cent. Debentures	100	114-117
City of London, Ordinary	10	15½-16½
—— 6 per cent. Cumulative Pref.	10	16-17
—— 5 per cent. Debenture Stock	100	128-133
City and South London Railway, Consolidated Ordinary	100	53-55
—— 4 per cent. Debenture Stock	100	136-138
—— 5 per cent. Pref. Shares	10	15-15½
County of London and Brush Provincial Co., Ordinary	10	8-9
—— 6 per cent. Cum. Pref.	10	13¾-14¼
—— 4½ per cent. 2nd Debenture Stock	5	7½-8½
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1¾-2¼
—— 5 per cent. Debentures	—	96-100
Edison and Swan United Ordinary	3	1¾-2¼
—— 5 per cent. Debentures	5	3-4
—— 4½ per cent. Debentures	100	103-106
Electric Construction, Limited	2	1¼-1¾
—— 7 per cent. Cumulative Pref.	2	2½-3
Elmore's Copper Depositing	2	½-¾
Elmore's Wire Company	2	¼-½
W. T. Henley's Telegraph Works, Ordinary	10	17½-18½
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	109-114
House-to-House Company, Ordinary	5	4¼-4¾
—— 7 per cent. Preference	5	8½-9
India Rubber and Gutta Percha Works	10	20½-21½
—— 4½ per cent. Debentures	100	105-108
Kensington and Knightsbridge Ordinary	5	10-10½
—— 6 per cent. Pref.	5	8¼-8¾
London Electric Supply	5	1-1¼
Metropolitan Electric Supply	10	13-14
—— 4½ per cent. First Mortgage Debenture Stock	100	121-124
National Telephone, Ordinary	5	7-7½
—— 6 per cent. Cum. First Pref.	10	17-19
—— 6 per cent. Cum. Second Pref.	10	17-19
—— 5 per cent. Non. Cum. Third Pref.	5	6⅜-6⅞
—— 3½ per cent. Deb. Stock	100	105-108
Notting Hill Company	10	9½-10½
Oriental, Limited, £1 shares	1	1½-2 xd
—— £5 Shares	5	8½-9 xd
—— £4½ shares	4½	7½-8 xd
Oriental Telephone and Electric Company	1	¾-⅞
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	103-105
Southampton Electric Company	5	4¾-5¼
St. James's and Pall Mall, Ordinary	5	12-13
—— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	39-42
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	6	7¾-8¼
Westminster Electric Supply, Ordinary	5	10½-11½
Yorkshire House-to-House	5	7½-8

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NOTES.

Lucium.—Mr. Crookes has been experimenting with salts of lucium, supplied to him by the patentee of that substance, and has come to the conclusion that it is not an element, but simply impure yttrium.

Obituary.—Mr. Francis Stradwick Harwood, superintendent of the Eastern Company's submarine telegraph station near Lisbon, died last Friday. He had resided in Portugal for over 25 years, and was much esteemed by the British community, the Portuguese authorities, and the numerous staff under his orders.

The Ionic Theory.—According to the results of H. Euler, given in the *Zeitschrift für Physikalische Chemie*, on warming a solution of benzoic acid the "ionisation" increases until 35deg. C. is reached, and then decreases. From this it is inferred that heat is absorbed by the change of the molecule into the ions at temperatures lower than 35deg., and evolved at higher temperatures. Meta-oxybenzoic acid has a maximum ionisation between 25deg. and 30deg.

Wireless Telegraphy.—It is stated in the *Shipping World* that the experiments in wireless telegraphy that Mr. W. H. Preece has been practising between the Penarth coastline and the signal stations on the Holms are to be resumed as soon as the weather permits. Last year Mr. Preece was enabled to interchange messages between the land near Lavernock Point and the lighthouse on the Flat Holm, and subsequently similarly successful efforts were carried out between the mainland of Lorne and the island of Mull.

Personal.—A dinner was given last Saturday at the Holborn Restaurant by the heads of the Ediswan sale departments to Mr. C. M. Downie in order to present him with a silver salver on the occasion of his resignation. Mr. Bishop (Birmingham) took the chair, Mr. Cox (Liverpool) the vice-chair, and complimentary speeches were made by Mr. Wheatley (London), Mr. Wyatt (Cardiff), Mr. Murray, Mr. Scarr, and others. Mr. Gover, the secretary to the Edison and Swan company, was unable to be present, but sent a telegram. The duties of secretary to the testimonial fund were performed by Mr. Scarr.

Foreign Patent Sales.—"With care and diligence one may be acquainted with the common law; but with the statutes, no man." The attention of owners and sellers of patent rights may therefore be called to the decision of the Court of Appeal that patent rights in New South Wales cannot be described as "property locally situate out of the United Kingdom" for the purpose of escaping duty under the head "conveyance on sale" in Section 1 of the Stamp Act, 1891. Patent rights, being "incorporeal," cannot be said to be "locally situate" anywhere. That is the theory, but neither the logic nor the justice of it are quite clear to the lay mind.

Exhibitions.—The Associated Chambers of Commerce have sent out a circular to the chambers informing them that Sir Stafford Northcote has been made the chairman of the commercial and industrial section of the Victorian Era Exhibition, 1897 (Earl's Court), and stating that its object is to bring together exhibits illustrative of the progress effected in different branches of British trade during her Majesty's reign as well as the present condition of the manufacturers of the United Kingdom. "It is understood," says the circular, "that exhibits which fulfil these conditions will be admitted free of charge for space." A meeting has also been held at the Mansion House, at which the Lord Mayor presided, to consider the steps to be taken to raise the necessary funds for securing an adequate representation of British art in the fine-art section of the forthcoming Brussels International Exhibition.

A Labour-Saving Appliance.—An American has invented an electrical door opener, and the Chicago *Electrical Journal* devotes more than two pages with three excellent illustrations and a diagram to explain how by stepping on the mat a contact is made which actuates mechanism causing the door to open. The complete installation includes a storage battery (110 volts), an electromotor with a worm gear, wires, switches, etc., besides the levers, pulleys, and other purely mechanical parts of the apparatus necessary to do the work. The cost of the arrangement is not stated, but our contemporary heads its article: "Successful Door Opener. The Hicks-Troy Mechanism of World's Fair Fame now Perfected and in Commercial Operation. Description of the Unique Mechanism." A captious critic might easily read that in a sense not intended. We know of old the American eye opener, but many of the American door openers we do not expect to see on this side of the Atlantic so long as a spring swing door can be successfully opened by a simple push.

Institution of Civil Engineers.—At the ordinary meeting last Tuesday Mr. John Wolfe Barry, C.B., F.R.S., the president, in the chair, two papers dealing with the treatment of coal at the surface of the pits were read. The first communication, on "Screening and Tipping Coal," by Mr. James Rigg, embodied an account of the various forms of screening and tipping machinery employed in recent practice. Great importance was now placed upon the preservation of coal from damage in loading, screening, and in transit. The rate of increase in the amount of coal raised in the United Kingdom for manufacturing purposes had greatly exceeded that for domestic use, so that the supply of coal per head of the population was now more than double its amount 33 years ago, while the population had barely increased 50 per cent. The second paper, by Mr. Thos. Gillott, M.I.C.E., was devoted to a description of "The Surface Plant at Kirkby Colliery." The papers will be for discussion next Tuesday, and, time permitting, a paper on "Steel Skeleton Construction in Chicago," by Mr. E. C. Shankland, M.I.C.E., will be read afterwards. There is a students' meeting on December 18 ("Well-Sinking," by Mr. Kitchen.)

Rontgen Radiations.—Prof. Silvanus Thompson says Röntgen radiations will not render solid insulators "leaky." If so, Prof. J. J. Thomson is wrong—and other people. But Prof. Oliver Lodge says that Prof. Silvanus Thompson is wrong, and that there is a distinct leak from a terminal buried in paraffin when the latter is under the influence of the rays. It is to be hoped that these eminent professors will settle the matter one way or the other, because it is so annoying for other people to frame theories or explanations founded on a particular fact and then to find that, after all, it is not true. As to gaseous insulators, Mr. M. A. Becquerel states that the invisible radiations from uranium salts will make them bad insulators just in the same way as the Röntgen rays. Further, Mr. Jean Perrin finds that the discharge in gases under the influence of the Röntgen rays is proportional to the absolute temperature, and independent of the pressure. (This would favour the idea that it is a dissociation phenomenon, and assimilate it to "ionisation" in a liquid.) Lastly, Prof. O. J. Lodge gives a useful hint in *Nature* to those who use a Wimshurst machine to produce the radiations. It is to remember that the machine will not work well when short-circuited.

The Metric System.—The Liverpool Chamber of Commerce has unanimously passed the usual resolution in

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favour of the adoption of the metric system of weights and measures. The suggestion that the coinage should be decimalised by dividing the pound into thousandths has been revived. It will be held impossible for various reasons in England, but it has been carried out successfully in Egypt to the great convenience of those who dislike piastres and paras. Mr. Joseph Jonas has called attention to the fact that Watt (the great Watt) was the real inventor of a systematic decimalising of weights and measures, and publishes some interesting letters of Watt's on the subject. It is quite in accordance with custom for a thing to be invented in Britain and go to the Continent for adoption. When it has done that, those people who would not look at it in the first instance clamour for its importation. In this instance, as may be expected from its inventor, Watt's system would have worked out so as to give weights and measures of a much more convenient size than the metric system. In fact, it would seem that when the French took up the idea and carried it out, they more than half spoiled it with bad units and a pedantic nomenclature.

The Imperial Institute.—In the course of his lecture at the Imperial Institute last Monday on the subject of "The Diamond Mines of Kimberley," Mr. W. Crookes showed that if placed in highly-exhausted vacuum tubes, through which high-tension electric currents are passed, the diamonds from each of the South African mines possess a special characteristic phosphorescence. Under such conditions most South African diamonds shine with a bluish light. Diamonds from other localities shine with different colours, such as apricot, red, yellowish-green, or orange. We have known gentlemen who are usually described in South Africa as I.D.B.'s convicted, after pleading "found it in a spruit," on the ground that to an expert there is a difference in the colour of a mine and a river stone. Mr. Crookes's method carries the delicate question of identifying the origin of a stone yet a stage further. It is about one of the last ways in which one would have expected "high-vacuum" experiments to have a practical use. Mr. Crookes further said that large diamonds were not nearly so uncommon as was supposed. It is stated that the Imperial Institute authorities intend to commemorate the sixtieth year of the Queen's reign by holding an exhibition in connection with our national fisheries, and that the Duke of York has agreed to take an active share in the work of organisation.

Forthcoming Events.—To-day (Friday) the Physical Society meet at 5 p.m. at Burlington House ("Seismology" and "Musical Tubes").—There is also a meeting of the Astronomical Society.—To-morrow (Saturday) a meeting of Elmore's Copper Depositing Company has been announced (Cannon-street Hotel, 12 noon).—Monday (December 14) is the date for the Cantor lecture at the Society of Arts.—On Tuesday the Institution of Civil Engineers discuss last week's papers on colliery plant, etc., and if time permits take a paper by Mr. Shankland on "Steel Construction in Chicago" (Great George-street, 8 p.m.).—At the Wednesday meeting of the Society of Arts the subject is "The Chamber Music of Purcell, Handel, and Bach," by Arnold Dolmetsch (John-street, Adelphi, 8 p.m.). On the same evening (December 16) the Meteorological Society meet at 7.30 p.m. at the Institution of Civil Engineers, Great George-street, for papers on "An Attempt to determine Velocity Equivalents of Wind Forces estimated by Beaufort's Scale," by Richard H. Curtis, and on "The Winter Climate of Egypt," by H. E. Leigh Canney, M.D.—On Thursday there is a meeting of the Dundee Institute at Dundee.—Next Friday, December 18, at the Westminster Palace Hotel, the Junior Engineers take the paper on "Electric Central-Station Working," by Mr. P. W. McDougall, A.I.E.E., of Deptford, 8 p.m.—On Saturday, December 19, the North-East Coast Engineers meet at Hartlepool (6 p.m.) for a paper on "The Experimental Engines at the Durham College of Science, Newcastle-upon-Tyne," by Prof. R. L. Weighton.

Niagara.—The *Daily Telegraph* having failed in an attempt to present a testimonial to the United States Ambassador—which, if one could conceive him acceping it, would have driven some Americans frantic—has taken up the "beauties of Niagara" agitation. A "special correspondent" in New York has discovered that "a scheme is at work to spoil Niagara. Only a few days ago the American journals were rejoicing that at last the mighty giant was harnessed. Two or three years back a concern, calling itself the Niagara Falls Power Company, sought the right to intercept the current above the Rapids, and, by turning its energy into electricity, make dollars for themelves." Moreover, Chicago now sends her sewage (ultimately) into the Mississippi instead of into the lake. There are two columns of this sort of thing, but as our contemporary is rather behind the times in this special matter for an up-to-date daily one need not reproduce it. The right has been obtained, the work has been done, and the landscape and general amenities of the falls are none the worse for it. Moreover, all the world, except the *Daily Telegraph*, knows it. The Americans are quite capable of taking care of themselves, their country, their interests, and their ambassadors without our British assistance—and they very much prefer to do so. Why cannot our contemporary let them alone ?

Royal Institution.—At a monthly meeting of the members of the Royal Institution held last Monday, the special thanks of the members were returned to the Duke of Northumberland, president of the institution, for a donation of £200 to the fund for the promotion of experimental research at low temperatures; to Colonel Coleridge Grove for a bust of his father, the late Sir William Grove; and also to Prof. Dewar for a marble pedestal for the bust. Among the lecture arrangements before Easter are six lectures by Prof. Silvanus P. Thompson (adapted to a juvenile auditory) on "Light, Visible and Invisible"; Prof. Augustus D. Waller gives 12 lectures on "Animal Electricity"; Prof. Henry A. Miers, three lectures on "Some Secrets of Crystals"; and Lord Rayleigh, six lectures on "Electricity and Electrical Vibrations." Other lectures are by Dr. J. W. Gregory, Prof. Percy Gardner, Prof. W. Boyd Dawkins, Mr. Carl Armbruster, and Mr. W. F. Lord. The Friday evening meetings will begin on January 22, when a discourse will be given by Prof. Dewar; succeeding discourses will probably be given by the Bishop of London, Prof. Jagadis Chunder Bose, Prof. J. Milne, Dr. G. Johnstone Stoney, Lieutenant-Colonel C. R. Conder, Mr. Shelford Bidwell, Prof. Arthur Smithells, Sir E. Maunde Thompson, Sir W. Turner, Mr. C. T. Heycock, Lord Rayleigh, and others. The Davy-Faraday research laboratory, founded by Dr. Ludwig Mond, F.R.S., as a memorial of Davy and Faraday, is to be opened by the Prince of Wales on Tuesday, 22nd inst. The ceremony will take place in the theatre of the Royal Institution, where, by desire of his Royal Highness, Prof. Dewar will, after the opening ceremony, show experiments illustrative of the use of liquid air in scientific research.

Lenard Rays.—The paper read by Prof. Lenard at the German Association (Deutscher Naturforscher) gives an authoritative summary of his views as to the substantial identity of what are known in this country respectively as the Röntgen, Lenard, and cathode rays. The argument, put shortly, appears to be: Lenard and Röntgen rays have

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mainly similar properties, therefore they are much the same; but Lenard rays are only cathode rays that have been got outside the tube through an aluminium window. Therefore they are all the same. But the Röntgen rays are ethereal vibrations either longitudinal or transverse. Therefore the cathode rays must be also of the nature of ethereal vibrations, and not a transfer of charged molecules. The writer does not accept the theory, but hopes he has stated it fairly above. The difficulty of devising and carrying out a crucial experiment to determine the point appears to lie in the impossibility of getting cathode rays unattended with Röntgen rays, using the latter term to mean radiations arising from the impact of cathode rays on some other substance. There is also the fluorescent light in the tube to be accounted for, and, in fact, any radiation produced by the collision of opposing streams of molecules. On the other hand, while the Lenard rays seem the same as the cathode rays, it is almost impossible to conceive how a molecule can penetrate the aluminium window—if they did, in time the degree of the vacuum would alter; nor is Sir George Stokes's suggestion that the impulse of the impinging molecule is transmitted through the thin plate and starts off another molecule from the outside surface much more easily acceptable. Should Prof. Lenard's theory prove the correct one, the priority of discovery of the Röntgen radiations will belong to him, leaving to Prof. Röntgen the discovery of their action on the sensitised plate and their practical application.

Telegraph Statistics.—The telegraphic statistics of various countries for 1895 have been summarised and tabulated in the *Journal Télégraphique*, which, as the official organ of the Bureau International, has exceptional means of obtaining information on the subject. So far as length of line goes, Germany comes first with 132,000 kilometres of line, as against France with 93,000, the United Kingdom with 59,000, and India with 71,000. If, however, length of wire is taken, the numbers are—Germany, 490,000; France, 317,000; United Kingdom, 369,000; and India, 219,000. It is not worth reproducing anything beyond the thousands, as now that 11 months have elapsed since the tables were compiled the figures must be already more or less obsolete. For her length of wire Germany had 20,723 offices open; France, 11,553; the United Kingdom, 9,926; and India, 4,046. Of the Indian offices, about two-thirds are scheduled as not receiving foreign messages. There is a similar distinction in Sweden and some other countries, but the proportion is not quite so great. Apparatus are tabulated as Morse, Hughes, and "other systems." The proportion of Morse to others in Germany is 16 to 12; in France, 12 to 6; and in the United Kingdom, 5 to 23. The numbers represent the thousands of instruments. With the exception of Holland, where it is nearly equal, and Roumania, where it is reversed, the Morse show a preponderance elsewhere. As to numbers of messages paid for—in Germany it was 24 million; France, 34 million; United Kingdom, 70 million; and India, 4 million; from which it will be seen that on the average the lines are more worked in this country than anywhere else, or, what is the same thing, the number of messages held to justify a line being erected is higher. The number of foreign telegrams sent were: Germany, 4¼ millions; France, 2¾ millions, and the United Kingdom 4½ millions. These do not include the messages that came through those countries. It is curious that the number of foreign messages received does not in most cases correspond so nearly with those sent as might be expected. The activity of the Germans in foreign trade compared with the French, however, makes itself sufficiently evident in the figures. It may be added that there are no statistics published as to Russia, and none for any of the South and Central American States. For the United States the figures of the Western Union Company are given, but they are not complete.

Accidents and Explosions.—An inquest has been held at Manchester on the death of an electrician named Thomson. Whilst laying electric wires along a ceiling of a factory, the wire he was handling caught a revolving shaft. The deceased was dragged off the scaffold, and the wire tying him on the shaft, he was dragged round till the machine could be stopped. A verdict of "Accidental death" was returned.—An electrician named George Thwaites has been admitted to the Royal Hospital at Belfast, suffering from injuries received while engaged at work in the electric light station. It seems that Thwaites, who is in the employment of Messrs. Holmes, of Newcastle-on-Tyne, was making some extensions on the switchboard, when he accidentally short-circuited the voltmeter leads of one of the dynamos. He was rather severely burned about the face and hands.—About 10 o'clock on Sunday night one of the telegraph street boxes opposite Charing Cross railway station blew up. The explosion appears to have been more violent than usual, but no one was hurt.—An extraordinary and almost incredible report has been published as to the boiler explosion at the electric carbon works at Nanterre, near Paris. It is stated that a crack developed in the boiler and was simply caulked with tarred paper. "As the water no longer escaped from the place where the fissure had been, the steam was brought up to the normal pressure." As we stated last week, the works were wrecked.—When the fire occurred at St. George's, Hanover-square, some three or four weeks ago it was reported that the cause was "fusion of the electric wires." An examination by experts has shown that this could not have been the case. Except on the principle of when you don't understand a thing say it is done by electricity, there appears to have been no foundation for the rumour.—In reference to the bursting of a hydraulic main on St. Andrew's-hill on Sunday week, and the consequent flooding of the transformer sub-station, the Rev. Mr. Clementi Smith has written another letter in which he practically says that he got his idea that there would be "an explosion" from one of the City of London Company's servants. It is easy to suppose that both the police inspector and the reverend gentleman got somehow an exaggerated idea of the danger (to the public) that could possibly ensue, but Mr. Clementi Smith should have enquired further before summarily demanding the abolition of underground transformer sub-stations.

Societies and Institutes.—The *Times* said that Lord Rayleigh's retirement from the council of the Royal Society was "significant." Lord Rayleigh promptly wrote, "Permit me to say that my retirement is significant only of a desire to escape engagements involving journeys to London and of a possibly mistaken impression that the position of an ex-secretary as an unofficial member of council would be a little anomalous." *Nature* takes the *Times* to task in a very high manner about it. In a dispute between two such august institutions as the *Times* and the "Royal" most people would not hurry to intervene. It may be added that the other night Sir Walter Besant called the Royal Society a trade union or a mediæval guild—he did not seem quite certain which. But a great novelist may call anybody anything.—On Saturday night Sir Edwin Sandys Dawes delivered his presidential address to the members of the Institute of Marine Engineers. There was a conversazione afterwards.—At last week's meeting of the Society of Chemical Industry, Dr. Schunck presiding, Dr. Stevenson Macadam, of Edinburgh, read a communication on safe and unsafe mineral oils for domestic lighting

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His point was that there was no real necessity for the use of unsafe oils.—Last Saturday about 50 members of the Liverpool Engineering Society paid a visit to the Liverpool Gas Company's new works at Garston, and inspected the plant which has recently been laid down there.—At a meeting of the Royal Colonial Institute held on Monday Sir Harry H. Johnston read a paper on "England's Work in Central Africa." The chair was taken by Lord Loch, who, speaking of Lake Nyasa and Lake Tanganyika, said he believed they might look at no distant date for a settlement of those vast regions which would bring them into telegraphic and other means of communication right up through the centre of Africa to Gondokoro and Khartum. (Telegraphic communications have not been very good lately even in some parts of Rhodesia.)—The Glasgow Philosophical Society have presented Lord Kelvin with an address, and placed him on the roll of honorary members. A bust of Lord Kelvin was presented to the society, and the subscribers also presented a replica of it to Lady Kelvin. The address from the Institution of Electrical Engineers was read, and then there were votes of thanks.—Lord Rayleigh and Prof. Ramsay have been elected corresponding members of the Berlin Academy of Sciences.—A list of some meetings and fixtures for next week is given in another note.

A High-Tension Shock.—Dr. W. S. Hedley, of Mansfield-street, in a letter to the *Lancet* has given some particulars of a 2,500-volt shock which came under his notice : "On November 20 an electrical engineer was standing on a chair ready to move a reversing switch on the arc lamp side of a rectifier for lighting a series of 60 lamps (3,000 volts). He casually placed his hand on the metal cover of an ammeter (which was in series with another 60-lamp circuit), and turning to the left and leaning back to make an observation (still standing on the chair) he placed his left hand on an iron pillar. Now the ammeter case proved to be in metallic contact (accidental) with the light leads, and as the return wire was 'earthed' there played through the body from hand to hand a current under a pressure of (nominally) 3,000 volts. As a matter of fact, the E.M.F. tested between the points of contact by a Kelvin electrostatic voltmeter proved to be 2,500 volts. He says that the first thing he realised was that he found himself standing on the floor, but has no clear idea as to whether he jumped off or was 'knocked off.' The forearm was 'drawn up close to the chest,' and the hands clenched. From a little above the elbow downwards he described a 'feeling of pulsation' and a violent beating in exact step with the alternators (running 83 periods per second). All power of movement below the elbow was absolutely lost, but the arm at the shoulder could be moved from the side. The pulsations, although still retaining their periodicity, soon became less violent, and motor power returned successively in the muscles that move the elbow, wrist, and fingers. In three minutes he felt 'none the worse.' There was no sensation of burning at the moment, but 10 minutes afterwards the hands became painful, and examination showed a burn on the tip of the middle and ring fingers (l) and on the back of the little and ring fingers (r) with a seared line across the lower portion of the palm. There has been no other effect excepting that he expresses himself as feeling 'decidedly better in general health.'" As to the violent beating in exact step with the alternators, there must be surely some mistake. There is generally a false sensation after any exceedingly strong impression on the nerves which persists some time after the cause has ceased, but 83 impulses per second (it should really be 166) are much too rapid to be separately appreciated. It may be added that Dr. Hedley estimates after experiments that the current taken was about a quarter of an ampere, but of course the resistance of hand contacts of such a character as described above is not a matter that can be determined with any accuracy.

Motorcarts.—The Scotch Office has been decidedly behind both England and Ireland in getting out its motor-car regulations, but Lord Balfour, Secretary for Scotland, has now issued them. There are differences in the speed allowed, which is lower than elsewhere in the United Kingdom. Under Article 4 of the Scotch regulations a person driving or in charge of a "light locomotive" when used on the highway "shall not, under any circumstances, drive the light locomotive at a greater speed than 10 miles an hour. If the weight unladen of the light locomotive is one ton and a half and does not exceed two tons, he shall not drive the same at a greater speed than eight miles an hour, or if such weight exceeds two tons at a greater speed than five miles an hour. Provided that whatever may be the weight of a light locomotive, if it is used on any highway to draw any vehicle he shall not, under any circumstances, drive it at a greater speed than six miles an hour.' In reference to Mr. Lawson's audacious proposition of a motorcart "Derby," Mr. Dorling, the managing director to the Epsom Grand Stand Association, says that no motorcar races will ever take place on Epsom Down. Of course not; such a gross betrayal of the "noble animal" is not to be imputed to his closest friends and admirers. The Automobile Club are going to have a heavy motorcart race in France next summer on the lines of the Paris and Marseilles race of this year. The *Daily Mail* says people who drive motorcarts with them should not leave their whip at home. It is not suggested that they want it to whip the motor, but for the boys who otherwise will "ride behind." News goes slowly in the Welsh marches, and the General Purposes Committee of the Oswestry Town Council has just presented a recommendation that the Board of Trade be requested to make regulations under the Locomotives and Highways Act limiting the speed of motorcarts at Oswestry to six miles per hour. Even Scotland has got its regulations by this time. However, the matter was duly debated, and an amendment that the speed allowed be eight miles an hour was rejected. According to *Invention*, the biggest motor vehicle in the world is in Australia; but it came from America, so that continent does not lose its monopoly of the biggest things. It is to run from the coast to Coolgardie, and to condense its exhaust so effectually as not to require to take in water on its 400-mile journey. It is to be hoped this is more authentic than the original Parisian motorcar we spoke of last week. Finally, the *Engineer* has come out with an article condemning all existing designs of motor vehicles. The right way of doing things is not to take up existing types of vehicles, remove the shafts, and couple an oil-engine to the hind wheels. The combination is simply ungainly. "The motorcar of 1896 is very far from possible perfection. It is little more, indeed, than a gas-engine in a cart, after all."

Electric Ploughs.—About three weeks ago the Establissements Maguin Company invited a large number of sugar-makers and agriculturists to Charmes to witness some electric ploughing trials. The trials were made in a large field belonging to Mr. Landrin, who, besides being largely interested in agriculture round Charmes, is the director of the Bertaucourt-Epourdon Sugar Works. According to a report of the experiments in the *Revue Industrielle*, the source of power was an ordinary farm portable engine, which was belted to a dynamo giving between 35 and 40 amperes at 500 volts (the engine must therefore have been about 30 h.p.). The dynamo ran at 800

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revolutions, and the current was taken by bare wires carried on rough improvised posts or stakes with porcelain insulators. The plough was a two-share one and reversible, being of the same type as those used for steam cultivation. On the plough is mounted a motor running at 400 revolutions, which by intermediate gearing works a windlass, round which passes a chain. Except for the loops on the windlass the chain is stationary, and is fixed at the end of the field to a movable anchor with a very broad flake. (A wheel anchor of the Howard type would probably have been better, but would be much more costly.) The motor thus gets a firm pull against the chain, and the motion of the latter is at the same time reduced to an absolute minimum. The speed attained by the plough is stated to have been about 75 yards per minute, or "about five times as fast as oxen" (plough oxen are too slow for anything). A rather deep furrow was drawn. The breadth of the work is not specifically stated, but the amount got through was nearly five acres in a 10-hour day. A direct comparison with existing agricultural practice on the basis of these figures is not easy, as a slight difference in the character of soil, the shape of the plough breast, and the way the work was done would so largely affect the result. But it may be taken that on ordinary land two horses drawing one share would do an acre in an agricultural working day, which, if meal times are deducted, is less than 10 hours. We have therefore, roughly, about 30 (steam) horse-power at the engine doing the work which would be accomplished by 10 actual horses, a result which, if one compares it with some electric tramway work, is for a first attempt far more promising than it looks. The method adopted—*i.e.*, that of warping along a chain—is, as has been pointed out here before, undoubtedly the right one, but some of the details would be easily capable of improvement. The motor, for instance, in these experiments was fed by trolleys running on copper wires carried on stakes running parallel to the furrow, and which would obviously require shifting almost every time the plough crossed the field. An insulated cable coiling on a drum slightly larger than the hauling windlass would be a decidedly better feed, and if a wire rope were used for haulage instead of a chain, the uninsulated return might be through that. Lastly, it should be said that our contemporary claims for this method of mechanical ploughing that it is the realisation of an idea of Mr. Felin, of Sermaize, brought out more than 10 years ago. What that idea was we do not know, but if it was running the plough on a stationary chain rather than a moving rope, it was carried through the experimental stage in England long before that, but, of course, as it was never brought into practical use the invention would be an independent one, and would naturally arise in France, where there is a regular system of steam towing on that principle on some of the rivers. It is to be hoped that the facilities which the electric motor affords for its application to ploughing will result in rendering mechanical cultivation something more than the half success it has hitherto been.

Technical Education.—Sir Philip Magnus, in distributing the prizes on Wednesday night to the successful students of the Norwood Technical Institute, spoke on technical education, and reviewed the history of the polytechnic institutes in London and the provinces. His speech is interesting, as he estimated the amount spent on evening teaching, exclusive of interest on capital outlay for buildings, at over £175,000 a year. London institutes gave facilities, not only for technical, but also for literary and general education which were not obtainable on the same scale and on similar lines in any other capital in the world. As regarded both secondary education and the higher scientific training, we were still very far behind our German and Swiss competitors. Sir Philip commended the advice given by Sir William Hart Dyke in a letter to the *Times* that we should appeal to the patriotism of county and county borough councils, and look to those bodies, or to their education committees, acting in a judicial capacity and with *quasi*-magisterial responsibility, to receive and distribute among necessitous schools, whether Board or Voluntary, the grants in aid entrusted to them by the State. [But the average town councillor does not even know what "technical education" really means. What he likes is "a slap-up institute" which will look a "credit to the borough."] With regard to secondary education, nothing could have been more satisfactory than the reply of the Duke of Devonshire to the deputation which waited upon him on November 25. Sir P. Magnus ended with a panegyric on the virtues of the German clerk. Mr. Morley spoke on the same subject the same evening at Battersea. He defended party politics on the ground of the pleasure they afforded in the way of good oratory and taking sides [one may pay too dear for pleasure], and then came to business. In London, on polytechnics and similar institutions, a capital had been sunk of something like half a million of money; the annual revenue of these institutions amounted to £100,000 a year, of which no less than £25,000 came from the fees of students and members and £9,000 from money earned by the efforts of the students. Those who had studied the educational question seriously were aware that a London polytechnic was not the same thing as the German polytechnic. In German polytechnic institutions the students learned the highest, most important, and profoundest principles in connection with the scientific subject which they there studied. Their object in the London polytechnic institutes was a different one. It was that the craftsman, the man who made things and did things with the labour and the skill of his hand, should have opportunities brought within his reach of training, not merely in the mechanical details, but in the principles and the basis of his work. One very often heard of the workmen being complained of; but it was now being seen that the leaders and captains of industry, especially the employers and the heads of great manufacturing enterprises, must open their minds to the improving of scientific investigation and research and training both for the heads of the enterprises as well as for those who had the actual conduct and the carrying of them out. He thought that those great manufacturers had received a rather useful little fright about German competition. Englishmen seemed to him never to enjoy themselves so thoroughly as when they were in a panic. Mr. Morley quoted Mr. Mather to the effect that what was needed in various branches of engineering was more science, more accuracy, and more intelligence in the chiefs, managers, and foremen, and those who had to carry out the work. Too much attention was paid to athletics and sports in England. [This is not wholly confined to the "gentlemanly" classes.] The end of the speech was about a reform of the London University. If they were going to create a university in London, let them open the gates as wide as they possibly could. They had heard of librarians whose chief function was to prevent people from getting out books. Do not let them have a university the chief function of which was to prevent young men and women from taking degrees. In conclusion, he thought that there were two great superficial curses of our time in this country—our "secularity" [What does Mr. Morley mean by this?] and triviality. All this is, of course, the "literary" view of the matter. It is probably not much more wrong than the "practical man's" view.

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THE PRINCIPLES OF ALTERNATE-CURRENT WORKING.*

BY ALFRED HAY, B.Sc.(EDIN.), A.I.E.E.

(Continued from page 601.)

108. Consider a circuit made up of a conductor consisting of two hollow coaxial cylindric shells s_1 and s_2, as shown in longitudinal and transverse sections in Fig. 76. We may imagine the cylindric shells to be two thin tubes of copper placed coaxially and bent into the shape shown, the space between the tubes being filled with some insulating material which serves to keep them apart. Let the ends of the tubes or shells be connected by means of copper plates P_1 and P_2 soldered to them, and let a steady E.M.F. be introduced into the circuit so formed.

We have here the case of two circuits, s_1 and s_2, joined in parallel to a source of steady E.M.F. Let us investigate the law of growth of the current in each of the two circuits.

For the sake of simplicity, we shall suppose the cross-sections of the shells to be the same, so that both shells have the same resistance, say r. The magnetic field due to the current in s_1 is entirely confined to the region outside the inner boundary of this shell; similarly, the magnetic field due to the current in the outer shell s_2 is entirely confined to the region outside the inner boundary of that shell. From this it is at once obvious that the inductance

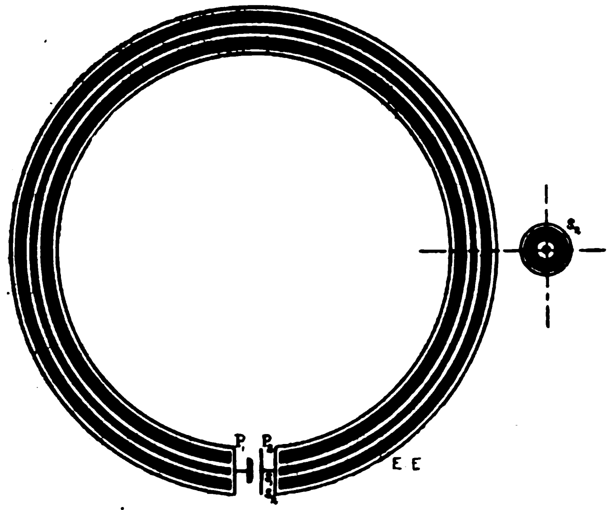

FIG. 76.

L_1 of s_1 is greater than L_2, that of s_2; for a unit current in either shell will produce the same magnetic flux outside the shells; and besides this flux, the current in s_1 produces a magnetic flux in the space between the two shells, whereas the current in s_2 produces no such flux. It is also at once obvious that the whole of the flux through the circuit s_2 must pass through the circuit s_1; in other words, the mutual inductance M of the two shells is equal to L_2, the inductance of the outer shell.

Since the two shells have the same resistance, but the outer shell a smaller inductance, we should expect (Art. 34) the rise of current to its steady value to be more rapid in this outer shell. Besides the effect of (self) inductance, however, we have also to consider that produced by the mutual inductance of the two shells.

Let E denote the steady E.M.F. simultaneously applied to the two shells. In each shell we have three E.M.F.'s, the sum of which must equal E. These three E.M.F.'s are:

(1) The $r\,i$ E.M.F., due to the resistance of each shell.

(2) The induced E.M.F. in each shell due to the changing magnetic flux produced by *its own* current.

(3) The induced E.M.F. in each shell due to the variation of magnetic flux caused by the current in *the other* shell.

If i_1 and i_2 stand for the instantaneous values of the currents in the shells s_1 and s_2 respectively, i_1' and i_2' for their rates of change, then we have the equations:

$$r\,i_1 + L_1\,i_1' + M\,i_2' = E;$$
$$r\,i_2 + L_2\,i_2' + M\,i_1' = E;$$

* Based on a series of evening lectures delivered at the University College, Liverpool.

which now take the place of the equations (α) and (β) of Art. 105. Now since $L_2 = M$, we may insert this value for L_2 in the second equation. Subtracting the second equation from the first, we obtain

$$i_1' = \frac{r\,(i_2 - i_1)}{L_1 - M}.$$

Again, multiplying the first equation by M, the second by L_1, and then subtracting the second from the first, we find

$$i_2' = \frac{E}{M} - \frac{r\,(L_1\,i_2 - M\,i_1)}{M\,(L_1 - M)}.$$

Using these equations and applying the step-by-step process explained in Art. 106, we may plot the curves showing the rise of current in each of the two shells.

109. The expressions obtained for i_1' and i_2' at once indicate a remarkable fact. At the commencement, when the time $t = 0$, and $i_1 = 0$, $i_2 = 0$, we find $i_1' = 0$, $i_2' = \frac{E}{M}$. In other words, while *the current in the outer shell s_2 at once begins to rise at a rapid rate* $\left(\frac{E}{M}\right)$, *the current in the inner shell does not begin to rise until the current in s_2 has reached a sensible value.* The curve showing the rise of current in the outer shell will make a certain angle with the axis of time at the origin, whereas the curve for the inner shell will be *tangential* to the axis of time, as shown in Fig. 77.

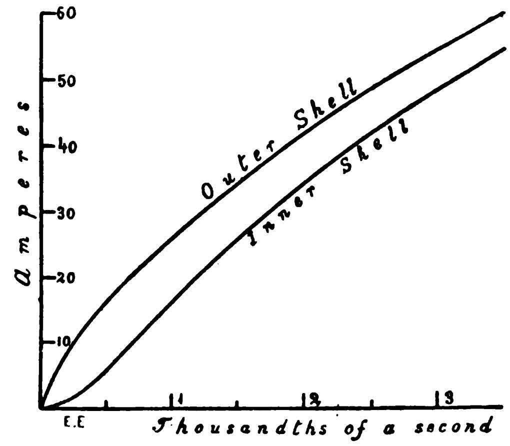

FIG. 77.

110. We shall apply these results to a numerical example Let $r = \cdot001$; $L_1 = 2{\cdot}5 \times 10^{-6}$; $L_2 = M = 2 \times 10^{-6}$, and let $E = \cdot1$. We then find

$$i_1' = 2{,}000\,(i_2 - i_1),$$
$$i_2' = 5 \times 10^4 - 1{,}000\,(2{\cdot}5\,i_2 - 2\,i_1).$$

Using the step-by-step process already explained (Art. 106) we obtain the following set of values:

$t =$	0	10^{-4}	$2{\cdot}33 \times 10^{-4}$	$4{\cdot}57 \times 10^{-4}$	$6{\cdot}75 \times 10^{-4}$	$9{\cdot}4 \times 10^{-4}$
$i_1 =$	0	0	1·33	5·21	9·47	15
$i_2 =$	0	5	10	15	20	25
$t =$	$12{\cdot}26 \times 10^{-4}$		$15{\cdot}27 \times 10^{-4}$	$18{\cdot}58 \times 10^{-4}$	$22{\cdot}1 \times 10^{-4}$	26×10^{-4}
$i_1 =$	20·8		26·3	32·1	37·7	43·3
$i_2 =$	30		35	40	45	50

These results are plotted in Fig. 77. The student will see that the rise of current is much more rapid in the outer shell.

111. Instead of two coaxial cylindric shells, let us next consider a *solid* cylindric conductor. Imagine the conductor split up into a large number of thin cylindric shells. The results deduced above may be applied to each pair of shells, and we are thus led to the conclusion that when a P.D. is established between the two ends of a cylindric conductor, the current rises in the surface layers of the conductor first, and only when it has attained an appreciable value in these surface layers does it begin to penetrate deeper into the conductor.

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Similar considerations hold good for a conductor of any shape. The current always starts from the *surface* layers and gradually becomes diffused over the whole cross-section of the conductor.

112. We next proceed to consider the problem of two circuits having mutual inductance, a simple harmonic impressed E.M.F. acting on one of the circuits.

Let r_1, L_1 and r_2, L_2 denote the resistance and inductance respectively of each circuit. We shall assume that the currents i_1 and i_2 in the two circuits follow the simple harmonic law, and that the current i_2 lags behind i_1, so that we may write

$$i_1 = I_1 \sin p\,t,$$
$$i_2 = I_2 \sin (p\,t - \theta).$$

If we suppose that e stands for the instantaneous impressed E.M.F. in the first circuit, then, by the principles explained in Art. 105, the currents must satisfy the equations

$$\left.\begin{array}{l} r_1 i_1 + L_1 i_1' + M\,i_2' = e \\ r_2 i_2 + L_2 i_2' + M\,i_1' = 0 \end{array}\right\} \quad . \quad . \quad . \quad (\epsilon)$$

where M is the mutual inductance of the two circuits.

Since we suppose i_1 and i_2 to follow the simple sine law, i_1' and i_2' will, by Art. 22, follow the same law, and their amplitudes will be $p\,I_1$ and $p\,I_2$ respectively. If we draw two rotating vectors, O A and O B (Fig. 78*a*), of lengths I_1 and I_2 respectively, and making an angle θ with each each other, then, supposing the angular velocity in a counter-clockwise direction to be p, the projections of these rotating vectors on the vertical axis will give the

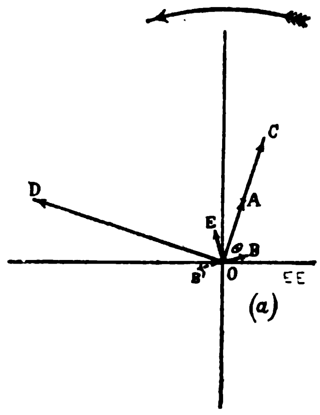

FIG 78A.

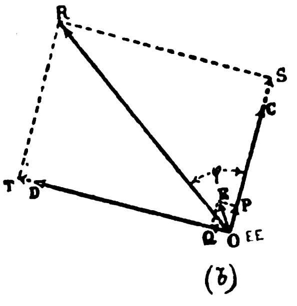

FIG. 78B.

instantaneous values of i_1 and i_2. The projection of a rotating vector O C, of length $r\,I_1$, will give the instantaneous value of the $r\,i_1$ component of the impressed E.M.F. The projections of two other vectors, O D and O E, of lengths $L_1 p\,I_1$ and $M\,p\,I_2$, and drawn at right angles to O A and O B respectively (Art. 22), will give the instantaneous values of the $L_1 i_1'$ and $M\,i_2'$ components of the E.M.F. respectively. By the first of the equations (ϵ) above, the sum of the projections of O C, O D, and O E on the vertical axis at any instant must give the value of the impressed E.M.F. at that instant. The amplitude of the impressed E.M.F. is therefore represented by the length of the rotating vector which is the resultant of the three vectors O D, O C, and O E.

In order to find this resultant, we replace the vector O E by two components (Art. 11), as shown in Fig. 78*b*, one of which, O P, is along O C, while the other, O Q, is along O D. By Art. 12, we have

$$O\,P = O\,E \cos P\,O\,E = M\,p\,I_2 \sin \theta,$$
and
$$O\,Q = O\,E \cos Q\,O\,E = M\,p\,I_2 \cos \theta.$$

Adding O C and O P, we obtain the vector O S; adding O D and O Q, we obtain O T, where

$$O\,S = r\,I_1 + M\,p\,I_2 \sin \theta,$$
$$O\,T = L\,p\,I_1 + M\,p\,I_2 \cos \theta.$$

Finally, compounding O S and O T, we obtain

$$O\,R = \sqrt{\overline{O\,S}^2 + \overline{O\,T}^2}$$
$$= \sqrt{(r\,I_1 + M\,p\,I_2 \sin \theta)^2 + (L\,p\,I_1 + M\,p\,I_2 \cos \theta)^2} \quad . \quad (l)$$

We have thus found the amplitude O R of the impressed E.M.F. in terms of I_1, I_2, and θ.

We next construct a vector diagram for the second circuit. This is shown in Fig. 79, in which $O\,L = r_2\,I_2$, $O\,M = L_2 p\,I_2$, $O\,N = M\,p\,I_1$; O M and O N being at right angles to O B and O A respectively. By the second of the equations (ϵ) above, the sum of the projections of O L, O M, and O N on the vertical axis at any instant must vanish. Hence the resultant of the vectors O L, O M, and O N must equal nothing. Proceeding as in Fig. 78*b*, we find that

$$O\,N \cos \theta + O\,M = 0,$$
and
$$O\,N \sin \theta = O\,L;$$

or, since $O\,L = r_2\,I_2$, $O\,M = L_2 p\,I_2$, and $O\,N = M\,p\,I_1$,

$$M\,p\,I_1 \cos \theta = -\,L_2 p\,I_2 \quad . \quad . \quad . \quad (m)$$
$$M\,p\,I_1 \sin \theta = r_2\,I_2 \quad . \quad . \quad . \quad . \quad (n)$$

Squaring these two equations, and adding, we get

$$I_2 = \frac{M\,p\,I_1}{\sqrt{r_2^2 + p^2 L_2^2}} \quad . \quad . \quad . \quad . \quad (o)$$

Again, dividing the second equation by the first, we find

$$\tan \theta = -\,\frac{L_2 p}{r_2}.$$

The angle of lag θ of the current i_2 behind the current i_1 is therefore greater than π (since its sine is positive and its cosine negative), and the actual position of the rotating vector O B is as shown by the dotted line O B′ in Fig. 78.

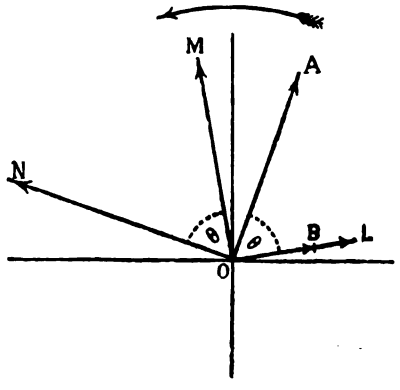

FIG. 79.

113. Using equations (l), (m), (n), and (o) of the preceding article, we may express everything in terms of the amplitude E (= O R, Fig. 78*b*) of the impressed E.M.F., and the resistances and inductances of the two circuits. We thus find

$$I_1 = \frac{E}{\sqrt{\left(r_1 + \dfrac{r_2 p^2 M^2}{r_2^2 + p^2 L_2^2}\right)^2 + p^2 \left(L_1 - \dfrac{M^2 p^2 L_2}{r_2^2 + p^2 L_2^2}\right)^2}} \quad (s)$$

Again, if ϕ denote the angle by which i_1 lags behind the impressed E.M.F., we see from Fig. 78*b* that

$$\tan \phi = \frac{p\left(L_1 - \dfrac{M^2 p^2 L_2}{r_2^2 + p^2 L_2^2}\right)}{r_1 + \dfrac{r_2 p^2 M^2}{r_2^2 + p^2 L_2^2}} \quad . \quad . \quad . \quad . \quad (t)$$

From equations (s) and (t) it is evident that if, while a simple harmonic E.M.F. of amplitude E is applied to a circuit of resistance r_1 and inductance L_1, another circuit, of resistance r_2 and inductance L_2, be brought near the first circuit and placed in such a position that their mutual inductance is M, then the first circuit behaves as if it had a resistance

$$r_1 + \frac{r_2 p^2 M^2}{r_2^2 + p^2 L_2^2},$$

and an inductance

$$L_1 - \frac{M^2 p^2 L_2}{r_2^2 + p^2 L_2^2}.$$

In other words, the apparent resistance of the first circuit

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is *increased*, and its apparent inductance *diminished*, by the presence of another closed circuit in its neighbourhood.*

(To be continued.)

RAILWAY BLOCK SIGNALLING.

BY J. PIGG.

(Continued from page 629.)

In certain cases absolute block working is not necessary in consequence of the character of the traffic dealt with, and is undesirable on account of its volume and the necessity for dealing with it in comparatively large batches. Such cases have to be dealt with in a different way. In many cases block working is dispensed with altogether, and the various trains signalled by bell only. In other instances a modified form of signalling, known generally as the permissive block, is made use of. Practically speaking, it is not entitled to the name, since no attempt is made to preserve the space limit between successive trains, which is the essential feature of the absolute block system. Probably two or three instances of actual use of this system, with the advantages obtained, will do more towards showing the necessity for, and the benefit accruing from, this method of working than anything else.

the section is further enhanced if a curve exists on the line or fog prevents the whole of the section being visible to the men at each end.

The instrument shown by Fig. 97 is used as an indicator of the state of the lines in the section A B at H. It is simply an ordinary S N block instrument, such as is used for absolute block working in other places, but differs in the lettering of the dial, and in provision being made to peg the handle in a *vertical* position as shown, in addition to the two ordinary positions on either side of the vertical. The dial is lettered on the upper left hand quadrant "Line occupied," and on the upper right-hand quadrant "Line clear." The lower half is lettered "Line blocked." Signals are given between A and B by means of separate bell communication in exactly the same manner as for absolute block working. If A transmits the "Is line clear" or "Be ready" signal to B on the bell, the response of the latter will depend upon the actual condition of the line. If the line is clear of trains, B will reply as per code, and peg the needles to "Line clear." If the line is already occupied, B replies to the bell signal as before, but pegs the needle to "Line occupied." These are the preliminary signals, corresponding to the "Line clear" signal in absolute block working, which are given on the approach of a train to A, and upon the answer given by B to this signal depends the action taken by A in forwarding the train into the section. If the needles are pegged to

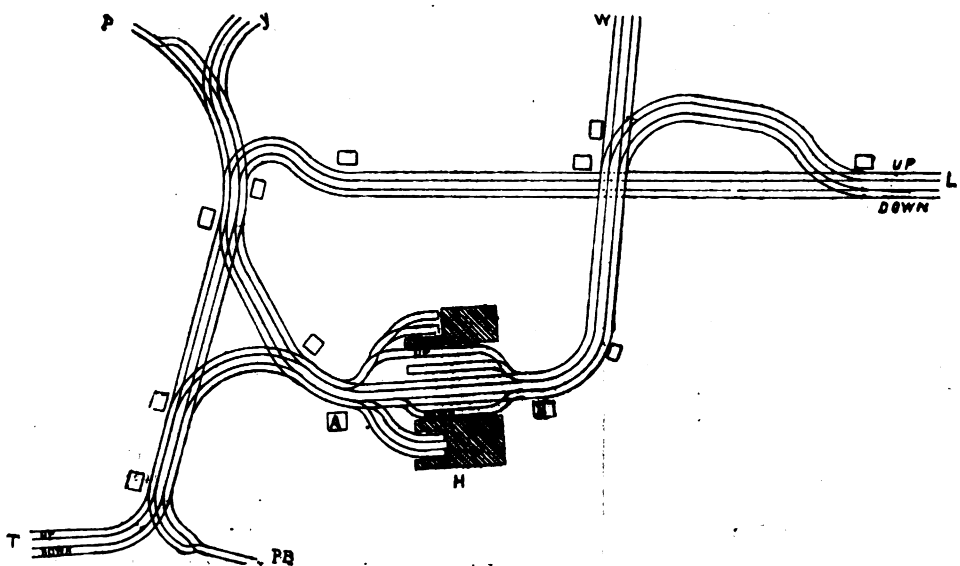

FIG. 96.

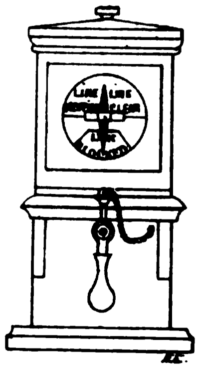

FIG. 97.

Three examples of lines on which permissive block working is in use are shown by Figs. 96, 98, 100. In Fig. 96, the passenger station, H, is the virtual junction for trains from T, P B, P, Y, W, and L. Trains arriving at H from P, Y, P B, and W proceed no further, and passengers travelling by these trains, *en route* for T or L, are transferred to other trains at H. It frequently occurs that a train from T is at the up platform when trains from P, Y, and P B which require to connect with it arrive. Hence these trains must pull up to the same platform, in order that passengers who desire to change for L may do so, the bays being too short and not sufficiently numerous to accommodate the later trains. Similarly, trains from W arrive on the down line with passengers to connect with a train already at the platform ready to proceed to T, Y, P, or P B. Hence block signalling, as commonly understood, cannot be carried on between A and B (Fig. 96).

If bell signals only are used in such a section, considerable responsibility rests upon the signalmen, and great care has to be exercised in order to ensure that trains shall not enter the section from either end at too high a speed in the event of the line being already occupied. Under such circumstances the signalmen have no reminder of the condition of the lines other than that afforded by the bookings in their train-books, and the danger of sending trains into

"Line clear," the signalman at A will lower the home signal, and allow the train to pass in the usual way. If the needles are pegged to "Line occupied," the train must be sent forward at caution, the home signal being kept at danger, and the train being brought forward by hand or other special signals. On the train entering the section A B, the usual "Train on line" signal is sent by A, and B, in response, unpegs the needles from "Line clear" or "Line occupied," as the case may be, and pegs the handle of his instrument in its vertical position, when, the needles at B and A being vertical also, the indication exhibited at both cabins is "Line blocked." As successive trains pass out of the section the "Train out of section" signal is given for each, as in the absolute system, the handle being pegged in the vertical position at the receiving end afterwards for all trains except the last one of any group of trains. When the last of any group leaves the section, it being then clear, the handle is unpegged, but the indication shown by the needles is unchanged and remains at "Line blocked." The difference of the indications, section clear of trains, and section occupied at the receiving end of the section, consists in the position of the peg for the handle, except during the time "Line occupied" or "Line clear" is being exhibited. In the first case the peg is inserted, as shown by Fig. 97; in the second case it hangs in front of the instrument by the chain to which it is attached. The right and left indications of the needle simply show that permission has been given for a train to enter the section: in the first case it may run straight in without

* Provided, of course, the two circuits are so placed that there is mutual inductance between them. If $M=0$, then, as the above equations show, the presence of the second circuit does not in any way affect the first.

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stopping; in the second case it is to be sent in at caution, it being an additional train.

In many cases it is often difficult for the signalman to communicate a hand signal to the driver of a train standing at the home signal. Obstructions to such signals being seen may arise from another train, standing on the opposite line, being between the driver of the train signalled and the signalman, and in this case the use of a hand signal, especially at night, is liable to be accepted by some other train than the one it is intended for. In such cases, subsidiary mechanical signal arms, or "calling on" signals, are fixed to the same post as the home signal, and are used as a signal to proceed at caution. These signals are, of course, used on the occasions when the "Line occupied" signal is exhibited, the ordinary home signal being used when "Line clear" is shown on the indicators.

It will be observed that this instrument has no provision for showing the number of trains signalled into or accepted in the section, and the signalman at the receiving end must, when conditions exist which prevent his seeing the whole of the section, rely upon his train-book for the information upon which depends his answer to any "Is line clear" or "Be ready" signal that may be offered for his acceptance.

Fig. 98 represents a section of line which, between the points A B, is worked partly by absolute and partly by the permissive system. The sidings shown constitute an important goods and mineral traffic distributing point. The lines between A and B are five in number, two of which constitute the main line, and are worked under absolute block rules; two are up and down independents, and are worked under permissive block rules, whilst the fifth line is a connecting link between the distributing sidings at A and a goods centre at B, and is not worked under any block rules. The construction of the distributing sidings is not such as to afford room for the shunting of more than one train at a time, and it is, therefore, of some importance to get completed trains out of the way as quickly as possible. Such trains are sent to B on the up independent lines, and, being worked under permissive rules, the traffic is dealt with in a much quicker and more effective fashion, since the departure of completed trains from the neighbourhood of the shunting ground is not dependent upon the absence of traffic on the main line, as it would be if the independent line did not exist, and the trains emerged direct on to the main line at A. The arrangement is such as to make B the virtual junction for the distributing sidings on the up side, with the further advantage that such trains complete a portion of their journey at the same time as traffic, which would otherwise delay them, is being carried on on the main line. Trains emerging on to the main line at B come under absolute block rules during their further progress. In a similar way, trains on the down line enter the down independent at B, and run direct to the distributing sidings at A, without further interference with the main line. The use of permissive block rules for the independents is obviously of more use for clearing the main line of a number of trains at such junctions as A and B for more important traffic than if the independents were worked under absolute block rules, since a number of trains may be put on the independent, instead of waiting till the line was clear of the previous train.

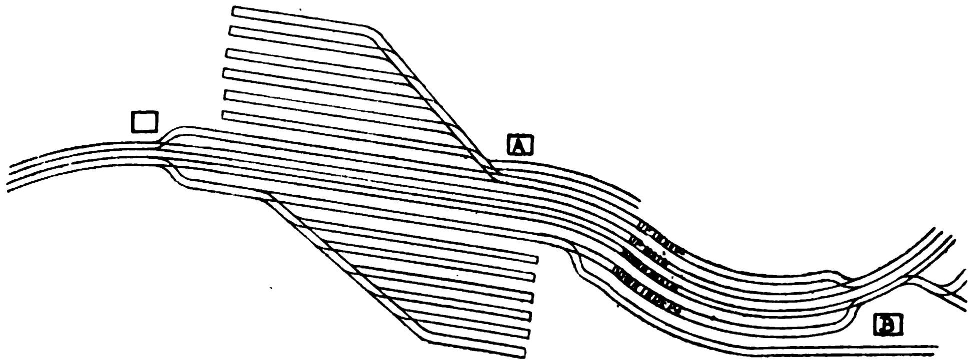

Fig. 98.

The form of instrument used at the receiving end of the section between A and B (Fig. 98) is shown by Fig. 99. This is Tyer's form of permissive block instrument. Its chief point of difference from the previous form of block instrument consists in the provision of means for advising the signalman of the number of trains in the section at any time. The commutator carries inside the instrument a small

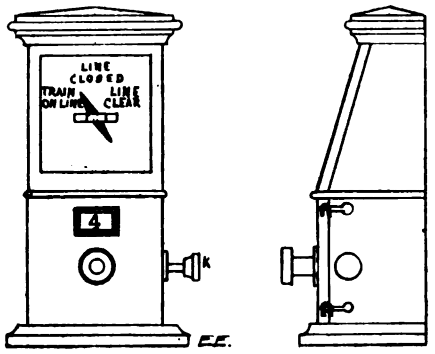

Fig. 99.

disc, around the circumference of which is painted "Line closed," "Line clear," "Train on line," "2," "3," "4," "5," "6." These indications are exhibited at the lower opening in turn, and in the order given above. These indications are mechanical, and are shown by turning the commutator handle, and they are in addition to the indications given by the needle. It will be observed that only when two or more trains occupy the section at the same time does the lower indication differ from that of the needle. The commutator is locked automatically in either of the eight positions it can occupy, and can only be turned forward or backward *during* depression of the small knob, K, on the right of the instrument. Hence, the movement of the commutator must be made deliberately, and it cannot be moved without special intention to do so. The ultimate capacity of a line on which such an instrument is in use would be six trains—*i.e.*, six trains might all be between the two block cabins, A and B, on one pair of rails at the same time. The instrument used at the sending end of the section is similar in appearance to Fig. 99, but it has no commutator or indicator of the number of trains in the section, and the signalman is not called upon to work it in any way.

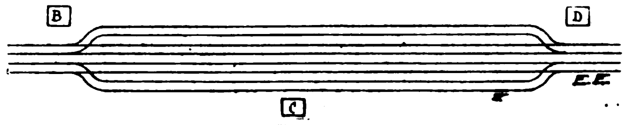

Fig. 100.

Another example of the conditions under which working of traffic under permissive block rules may be of advantage in facilitating traffic over crowded lines is shown by Fig. 100. On this line there is a large amount of fast passenger and other important traffic between two large and important towns, one of which is a seaport of some magnitude. In addition to this traffic there is a large amount of various kinds, but of less importance, in so far as time for delivery is concerned. Such traffic has therefore to give precedence to the more important. Under the absolute rules considerable delay would occur, and therefore in order to cope with

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the various classes of traffic the lines have been doubled for several miles. The original main line is worked under absolute rules, whilst the up and down independent lines are worked under permissive rules. Trains arriving at one of these junctions, with a small time margin in front of more important traffic, may be run upon the independent line alongside the train for which they have been diverted from the main line, and may be ready to continue the journey the moment they arrive at the exit junction. Practically no delay occurs to either class of train under these circumstances. Not only is this the case, but the main line may be rapidly cleared of a *number* of trains, since the permissive rules allow of a certain number of trains being in each section at the same time.

The form of instrument used on the section of line shown by Fig. 100 for the independent lines is given by Fig. 101. This represents Hampson's form of permissive block instrument. The apparatus for both lines is enclosed in one case. As in Tyer's form of instrument, indications of the number of trains in the section are exhibited at the lower opening, in addition to the dial indications; the dial signals are operated by the signalman at the receiving end only; the commutator and rear section recorder are locked in any one of the positions it can occupy, and the instrument is not adapted to transmit descriptive signals of any kind. As in Tyer's form all signals, other than the mere indication of the condition of the line, are made by a separate bell communication. The instrument is operated by the withdrawal

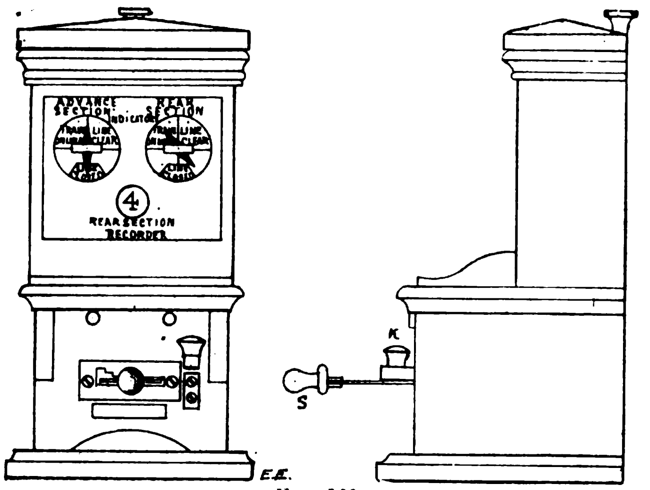

FIG. 101.

of the slide, S, which makes the usual simple commutator changes necessary to show "Line clear" and "Train on line" on the dials, and also imparts movement to a sector, passing behind the lower opening, which is lettered "Line closed," "Line clear," "Train on line," "1," "2," "3," "4," in order given. Movement of the slide from one position to the next in order, backward or forward, can only be made *after* depressing and releasing the knob, K, shown on the right of the commutator handle. In this respect Hampson's instrument differs from Tyer's. In Tyer's form the commutator must be turned during the time the knob, K (Fig. 99), is depressed, and it may, under these conditions, be placed in any of its positions. In Hampson's instrument the commutator slide can only be moved after the knob, K (Fig. 100), has been depressed and released, and it can then only be moved into the *next* position, forward or backward, as the case may be. At the same time there is nothing to prevent the releasing key of Hampson's instrument from being depressed any required number of times. The essential difference between Tyer's and Hampson's instruments is, that with the former it would be easy for a signalman to inadvertently turn the commutator through two positions instead of one; with the latter, the recorder can only be made to travel through two positions by two distinct operations of the releasing key, and must therefore be deliberately made.

It will be observed that the method of working with Tyer's and Hampson's instruments is slightly different to that described in connection with the instrument shown by Fig. 97. The difference consists in the double character of the preliminary signal in use with the latter form of instrument. The two former move more nearly on the lines of the absolute block, in so far as the indications exhibited are concerned: the latter form labours under the disadvantage of having two forms of indicator, the needle and the peg, one of which, the needle, exhibits the same signal whether the line is occupied by or clear of trains. In addition to this, it has the defect of not providing any record of the number of trains in the section at any time at either end. Tyer's and Hampson's instruments do provide such indications up to a prearranged limit depending upon the instrument, but they only do so at the receiving end of the section. It is sometimes contended that it is unnecessary to provide such indications at the sending end of the section, as the signalman there has the dial indication to guide him, and, moreover, cannot send a train forward until the "Be ready" or equivalent preliminary signal is accepted by the man at the receiving end. This contention would be unanswerable if there was anything of an automatic character in the indications, or if they depended in any way upon the trains themselves to act as a check. This, however, is not the case. The indications of the instrument are merely records of the movements of the signalman, and the construction of the locks is not such as will prevent a signalman from moving the commutator in such a way as will indicate a less number of trains than is in the section. If the number of trains in the section is two, say, and a third is sent in from the other end, there is nothing to prevent the signalman from inadvertently moving the commutator to indicate "Train on line," or one, instead of moving it so that it indicates "3." The instrument at the sending end would still indicate "Train on line," as it does whatever number of trains may be in the section, and there is thus no control or check other than vigilance in comparing the "Train out of section" signals with the bookings in the train-book. The exhibition of numbers, indicating the trains in the section, at the sending end, worked synchronously with those at the receiving end, and from that end, would provide a check against error on the part of the signalman at the receiving end, which, under certain circumstances, might be of great value.

Another feature of instruments of the class of which Tyer's and Hampson's are representative is an inevitable difference between the indications exhibited by the instruments and the actual condition of the line at a certain stage in the operation of signalling. The "Line clear" signal is, as already explained, a preparatory signal, and indicates an intermediate stage between line occupied and line clear of trains. Practically, it indicates the conversion of the line from a neutral condition to a state of preparation for the reception of a train which is known to be approaching. An examination of the methods of working will show that there is no such intermediate stage in the conversion of the line from the occupied to the unoccupied state. But in instruments of this class, where the indications for the exit of the last of a group of trains must be made in the exact reverse order to those for the entry of the first of the group, there must necessarily be a "Line clear" indication exhibited between "Train on line" and "Line closed." This, of course, is contrary to the actual conditions obtaining at the time. The "Line clear" signal so shown is, of course, exhibited for a short time only, and is considered of no significance. Such an indication, however, does not appear on any form of absolute block instrument. In this respect, Tyer's form of lock allows of more speedy movement from "Train on line" to "Line closed," since by keeping the knob, K (Fig. 99), depressed, the commutator may be moved at once over the two positions, the needle giving a mere kick to "Line clear" during the operation. In Hampson's instrument, the needles must stand at "Line clear" until the knob, K (Fig. 101), has been depressed and released a second time, and the slide pushed home.

(*To be continued.*)

Motor Development Corporation, Limited.—This Company has been registered, with a capital of £25,000 in £1 shares, to manufacture, sell, and deal in motors, tims, cycles, and other vehicles and carriages, and to carry on the business of engineers, machinists, fitters, founders, etc.

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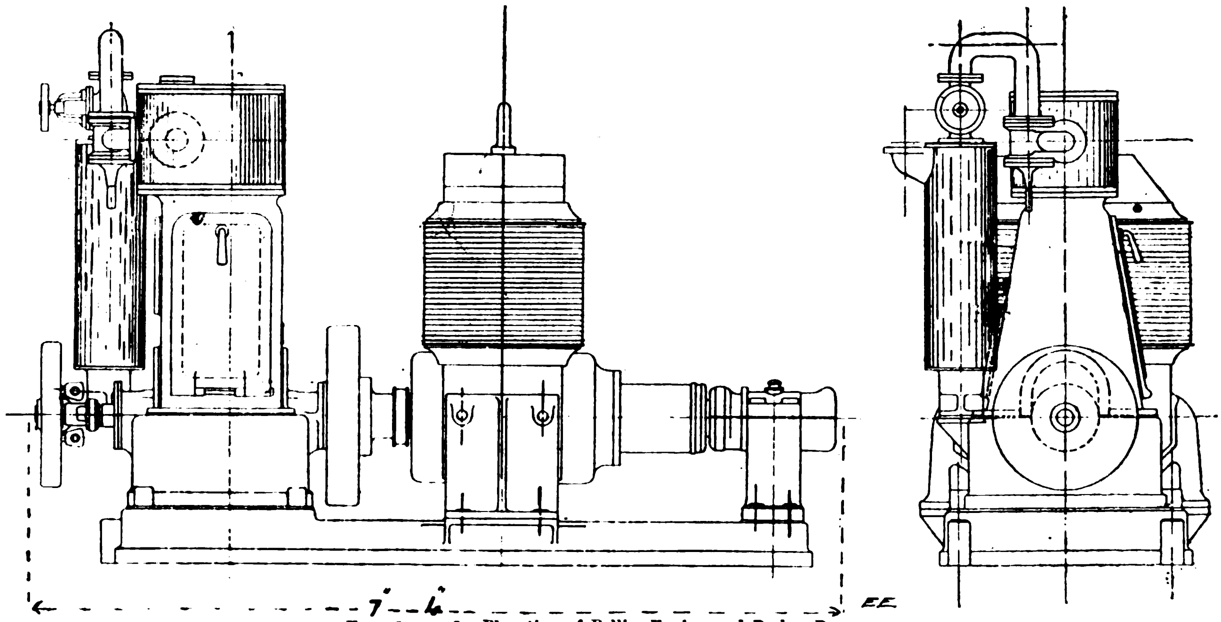
THE ELECTRIC LIGHTING OF S.S. "DRESDEN."

The "Dresden," the most recent addition to the fleet of vessels owned by the Great Eastern Railway Company, is 302ft. long, 38ft. beam, and 16ft. 6in. depth of hold. She is built with a long partial awning deck and poop and a raised forecastle, on the former of which are situated the first-class dining-saloon, ladies' room, staterooms, lavatories, and the accommodation for officers. On the lower decks, and entirely forward of the machinery and boilers, are the first-class staterooms, and in the large deckhouse are the saloon entrance, stateroom, and captain's room on the awning deck, with a spacious trunk skylight for light and ventilation to the saloon. The total number of first-class passengers provided for is 226, and the whole of the fittings and equipment for these are of the most modern and complete description, every detail which might add to the comfort of the passengers having been carefully considered. The arrangement generally is the same as in the steamer "Vienna" (the last vessel placed on the Hook of Holland and Harwich service), including a handsome special stateroom intended for the accommodation of distinguished passengers. An efficient system of fan ventilation is adopted so as to obtain a most ample supply of fresh air to the various spaces, and steam-coil stoves are provided for heating the vessel throughout. The second-class accommodation is also of a very comfortable kind, and situated in the poop and after 'tween decks for 20 passengers. The vessel is schooner rigged, with two light pole masts, to which will be fitted Tate's patent derricks and gear for the rapid handling of cargo and baggage, in addition to three powerful steam-winches. In the 'tween decks forward provision is made for the carriage of horses. Water ballast for trimming purposes is fitted, and the equipment of boats will be stowed on a boat-deck overhead, which will afford rain shelter for passengers, besides forming a convenient promenade on top.

The electrical installation on this vessel, which is a very complete one, has been carried out entirely by the electrical department of Earle's Shipbuilding and Engineering Company, Limited, Hull, by whom the ship and her machinery have also been constructed. The electric generating plant is situated in a compartment at the bottom of the ship, immediately abaft the engine-room, and consequently contiguous to the starting platform, which enables the engineer on watch to have a constant eye on it without leaving his station. It consists of two separate and independent sets of engines and dynamos, supplied by Messrs. G. E. Belliss and Co., Limited, Birmingham, each capable of supplying the whole of the lighting of the ship, so that in case of either an engine or a dynamo breaking down no inconvenience will be suffered by the passengers. The engines are of their well-known patent closed self-lubricating and noiseless type, coupled direct to the dynamos, which have been made by Messrs. Thomas Parker, Limited, of Wolverhampton. These coupled sets (shown in Figs. 1 and 2) are designed to give an output of 300 amperes at 50 volts. The engines give an output of 25 b.h.p. at 500 revolutions per minute, and are specially balanced for high-speed running. The lighting is arranged on the double-wire distributing-box system, the wires being lead-cased and the distributing boxes made of cast metal, specially designed and absolutely watertight. By this system, branch joints, etc., and their attendant evils are very largely obviated. Every part of the ship from stem to stern is lighted with electricity, including the masthead and side signals, the lamps for lighting the passenger and luggage gangways, and the promenade under the shelter deck. There is at each of the above-named gangways a very powerful cluster of lights, so as to make the roadway as bright as day. The main saloon is very fully lighted with 16-c.p. lamps, evenly distributed throughout, and carried by white-metal holders. In the lighting of the staterooms, the convenience and comfort of passengers has been closely studied. In addition to a very complete system of electric bell communication, there is telephonic communication between the smoke-room and bar, whereby thirsty passengers can at any time with the least amount of inconvenience call for and obtain their requirements. The heating of the ship by means of electricity was very carefully considered, and somewhat reluctantly postponed, as there seemed many advantages to be gained by such a system; but as there was not sufficient time to experiment with a view to avoiding any possible mistake, the further consideration was deferred. It is intended to drive the "Dresden" at a speed of 18 knots, and for that purpose she is fitted with two independent sets of triple-compound engines, each capable of driving the ship by itself in case of breakdown to the other at a speed of 14 to 15 knots; together the engines will indicate about 6,000 h.p. Steam is supplied from five huge steel boilers made in accordance with the Board of Trade rules and regulations for a working pressure of 160lb. per square inch, and tested by water pressure to 320lb. The whole of the machinery is designed and arranged with a view to safety as well as high speed, and herein lies one of the great advantages of twin-screw ships over paddle-boats, for in case of an injury to a paddle-wheel or a breakdown with a part of the engine, the ship is always detained for a considerable time and often has to be towed in, meanwhile being at the mercy of the wind and waves; whereas the twin-screw boat, whatever happens to one screw or engine, proceeds along as if nothing had happened, and with a reduction of speed so comparatively slight as to leave her still what may even in these days be called a fast boat. The life-saving appliances in these ships are not only in accordance with the rules and regulations of the Board of Trade, but have



FIGS. 1 AND 2.—Elevation of Belliss Engine and Parker Dynamo.

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in addition all that the modern inventor has introduced of any practical use, and all that science can suggest for the rescue of passengers and safely conveying them to land in case of disaster to the ship.

ON THE CATHODE RAYS AND THEIR PROBABLE RELATION TO THE RONTGEN RAYS.

[The following is the paper read before the German Association at Frankfort-on-the-Main by Prof. Lenard, who so narrowly missed being the discoverer of the Röntgen radiations. Unlike the prevalent opinion held in this country, Prof. Lenard holds that the cathode rays are of the same character as the Röntgen rays, and the paper sets forth substantially the evidence in favour of this view. In reading the paper, however, it must be noted that apparently Prof. Lenard includes under the term cathode rays not only the rays arising from the cathode inside the tube, but the same rays or such constituents of them as can be made to pass outside the tube by means of a metal plate or "window" in the glass of the tube. These are generally spoken of in this country as Lenard rays, owing to the fact that Prof. Lenard discovered their existence and experimented with them many months before Prof. Röntgen's discovery of the effect produced by the radiations from a vacuum tube in work on a photographic plate. A similar paper was read by Prof. Lenard at the British Association.]

The cathode rays as produced by the electric discharge in gases have long been known. To these a new kind of rays with kindred properties have been added by the recent discovery of Röntgen. The properties of these newly-discovered rays appear in the light of the present state of knowledge to be in agreement with the theory that they are essentially a limiting case of the cathode rays—that is to say, the Röntgen rays are cathode rays with infinitely small magnetic deflectibility. These rays, therefore, would consist of the same ethereal process as the cathode rays, but with a special value or series of special values of one of the parameters. What kind of theory this points to will now be indicated. By cathode rays are to be understood such rays as proceed from the cathode in a discharge tube.

In the first place, it is to be noted that we already are acquainted with an unbroken series of different kinds of cathode rays which differ only in the amount of their deflectibility by a magnet, just as different kinds of light are distinguished by their refrangibility in a certain medium. The deflectibility of a cathode ray remains the same throughout its whole course, be the gaseous or solid media through which it passes what they may, just as the colour of a light ray remains the same in analogous conditions. The case of fluorescence is an exception in the case of light, and, according to our theory, Röntgen's discovery has supplied an analogy to this in the case of the cathode rays—namely, the conversion of cathode rays of finite deflectibility into rays of imperceptibly small deflectibility by the action of ponderable matter.

Cathode rays of very great deflectibility and all intermediate grades down to comparatively small deflectibility can be produced in discharge tubes. The lower the gas pressure is in such tubes, and, therefore, the greater the electric forces which act upon the gas,* the smaller is the deflectibility of the rays produced. The smallest attainable deflectibility is reached by the application of the greatest electrical forces.

The known kinds of cathode rays have, so far as I have been able to prove it, the property of being absorbed by ponderable matter approximately in proportion to its density—that is to say, in so far as the amount of the absorption is determined by the medium it is twice as much for a medium of twice the density. This property, since independently of the amount of the deflectibility it is common to all kinds of cathode rays, appears to be a characteristic property. It is, as is well known, also a property of the Röntgen rays.

The different kinds of cathode rays have properties which vary gradually with the amount of their deflectibility. For example, so far as quantitative experiments have been made the less deflectible a cathode ray is the less will it be (1) absorbed by passing through a ponderable medium ; the less will it be (2) dispersed by it—that is to say, the less turbid the material is to it. This relation has been found to hold for cathode rays which issue from discharge tubes with thin windows, and which may, therefore, be considered to have undergone the smallest possible change in passing out. It is evident that cathode rays are the more accessible to investigation the less deflectible they are. For with rays of small magnetic deflectibility both the absorption and the dispersion is small. But these are the properties of the Röntgen rays.

Further properties of the cathode rays in relation to their deflectibility have not yet been investigated. Common to all kinds of cathode rays and to the Röntgen rays is the property of making gases conducting, and also the allied property of facilitating the formation of fog. Common also to all these rays is the property of exciting phosphorescence and chemical action.

From what has been stated above, the existence of a transformation of the deflectible into the non-deflectible rays in proportion to the amount of rays absorbed, appears to be probable. On the other hand, Lodge, J. J. Thomson, etc., consider it probable that the non-deflectible rays pass into the optical spectrum through the region of the rays recently discovered by M. Henri Becquerel.

* Condres has recently shown the electrical forces and not the gas pressure is what really determines the deflectibility ; he has, for instance, succeeded in producing cathode rays of small deflectibility with relatively high gas pressures by the application of great E.M.F.'s.

MOLECULES.

It has been more than once noted here that many people nowadays display a readiness to accept as incontrovertible results derived from the kinetic theory of gases which a careful examination of the facts that lie behind the mathematical formulæ does not by any means warrant. In particular there is the difficulty of putting helium and argon into their proper places on account of the "specific heat ratio." Mr. A. Noyes and Mr. Goodwin, in America, have endeavoured to check the correctness of the well-known law connecting this ratio and the number of atoms in a molecule, by comparative investigations on the viscosity of monatomic and polyatomic gases. The work is embodied in a paper which is reprinted in the *Physical Review*, and the conclusion arrived at is that the average cross-section of a mercury molecule (one atom) is nearly the same as a carbon dioxide molecule (three atoms), and 2½ times as large as a hydrogen molecule (two atoms). From this the authors infer that atoms and molecules are of the same order of magnitude, and that the spaces between the atoms in a molecule are not great. It does not, however, seem clear that the results obtained would not be satisfied by the exactly opposite supposition that the atom is exceedingly small compared with the size of the molecule, taking the latter expression to mean the region in which the joint attraction of the atoms is strong enough to sensibly affect the motion of another molecule. Upon either supposition their conclusion would follow that the viscosity of gases is not suitable for distinguishing between monatomic and polyatomic molecules. Since it seems probable that as much is not really known as to the intimate structure of a gas as is generally supposed, it is more than likely that our ideas of what exactly happens in a liquid, and particularly in an electrolyte, are still more wide of the mark.

INSTITUTION OF ELECTRICAL ENGINEERS, Dec. 10.

The annual general meeting of the Institution was held last night, when the statement of accounts, as published in our last issue, was presented, and the election of President, Council, and Officers, as given in our issue of November 20, was duly proceeded with, no other nominations having been made,

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HACKNEY.

The following is the conclusion of the report on electric lighting and refuse destructors presented to the Hackney Vestry by Mr. F. Hastings Medhurst, B.Sc., M.I.E.E.:

Extent and Description of Electrical Scheme.—It may be well to mention here that in 1893 the Board of Works for the Hackney district obtained an electric lighting provisional order. The order, like all other similar orders, contains schedule of streets in which it is expected that mains for electric lighting should be laid within two years from the commencement of the order. The local authorities may, if they think fit, lay mains in any other streets in the district as well, but the Board of Trade can, at their absolute discretion, revoke the order if the mains are not by the end of the year laid in the following streets: High-street, Kingsland; High-street, Stoke Newington; Kingsland-road (within the Hackney district); Mare-street; Stoke Newington-road; Dalston-lane. It is, however, more than probable that the Board of Trade will not arbitrarily exercise their powers of revocation if they can be convinced that the Vestry is giving the matter serious attention and preparing to carry into effect the obligations of the order. The above-mentioned streets appear to me to offer a very promising field for an initial installation. I should strongly advise you to provide a scheme for giving a public and private supply of electricity in these streets. Seeing that at the end of last year there were 36,238 lamps of 8 c.p. connected to the mains in the parish of St. Pancras, whilst at Blackpool, Bristol, Bradford, Glasgow, Huddersfield, and Manchester the numbers were 15,609, 36,615, 15,064, 62,560, 15,342, and 66,647 respectively, I think that I am justified in recommending you to provide an initial installation which will enable 16,000 private lights of 8 c.p. (or their equivalent) to be in electrical connection with the mains, in addition to the 140 arc lamps of 1,000 c.p. each, which will be required to efficiently illuminate the streets in question. It is extremely improbable that of the 16,000 lights more than 11,500 will ever be simultaneously alight, so that I have, in my estimate of cost, provided plant (exclusive of spares) for this number and for the 140 public arc lamps.

Generation and Distribution.—I have already pointed out the advisability of adopting a high-tension alternating-current system, with low-tension mains radiating from transforming sub stations. With the method of producing the requisite steam I have already dealt. The alternating current for private lighting will, during the night-time, be generated by "flywheel alternators" (as at Reading, Islington, Portsmouth, and Leicester) of 200 units each, while during the daytime I should recommend the employment of a high-speed vertical steam alternator of 100 units, or of a steam turbine alternator of the same output. The current will be conveyed by means of highly-insulated cables, laid in cast-iron pipes, to the transforming sub-stations (which latter need only be watertight cellars or vaults), and from the sub-stations the low-tension current will be conveyed to the consumers' premises by means of similarly but not equally insulated cables, likewise drawn through cast-iron pipes, with service boxes for connections to consumers' premises at convenient intervals. The transformer sub-stations would be capable of economically feeding a low-tension network of mains reaching to distances of about 250 yards from each sub-station, so that the sub-stations may be 500 yards apart. The current for public lighting would be generated by high-tension continuous-current dynamos and conveyed to the lamps by highly-insulated armoured concentric cables, laid direct in the ground.

Public Lighting.—I have already pointed out that it will, in my opinion, be necessary to erect 140 arc lamps of 1,000 c.p. each so as to give a good illumination in the four miles of street for which I have estimated the cost of an installation. There would be four arc lighting circuits. The lamps should be 100 yards apart on each side of the street, though the point immediately opposite any particular lamp on one side of the street should, where possible, equally divide the distance between two lamps on the other side. Alternate lamps should be on separate circuits, and half the lamps might with advantage be extinguished at midnight by merely actuating a switch at the generating station. The annual cost of lighting these streets electrically will be £1,800, or, according to data kindly supplied to me by your surveyor, Mr. Lovegrove, three times the present cost. Under existing conditions there are 188 gas lamps, costing in the aggregate £600 per annum. The parishes of Stoke Newington and South Hornsey pay collectively £81 towards this amount, so that if the arrangement I propose be carried out the parish of Hackney will have to receive £243 from the above-named parishes, and the cost to you of lighting the streets in question will then become £1,557, as against the present expense of £519. But the light from dusk till midnight will be 16 times greater than at present, and from midnight till dawn eight times as powerful. That the lighting of the streets in question is at present anything but satisfactory will probably be readily admitted. Nor should it be forgotten that the estimated reduction in the cost of refuse disposal is equal to over three times the difference between the present cost of lighting these streets by gas and the expense of illuminating them electrically.

Financial Considerations.—It has already been stated that the scheme I propose will, in addition to the public lighting, provide for 16,000 private lights of 8 c.p. in electrical connection with the mains. I should recommend that at the commencement 5d. per unit be the price charged to private consumers. At this rate the electric light will correspond in cost to gas as 2s. 6d. per 1,000 cubic feet. This will, I believe, be the lowest rate charged to consumers in London for the use of current used during the night. In Newcastle the average price is under 4½d. per unit, owing to the low cost of fuel. Yet at Newcastle the cost of coal per unit has always been very much greater than it will be at Hackney if my recommendations are carried out. Experience in similar London and provincial districts demonstrates that an average consumption of 20 units per lamp per annum may be safely counted on. This would give an output of 320,000 units per annum for private lighting, whilst the public lighting of the streets, which have already been scheduled, will require an additional output of 190,000 units; in other words, 510,000 units is the estimated annual output of the installation. I now beg to submit for your consideration the following estimates of capital outlay and of revenue and expenditure:

ESTIMATES OF CAPITAL.

Buildings and inclined roadway for a refuse destructor of 18 cells (three spare), together with the 18 furnaces, the chimney shaft, and boiler-house; nine tubular boilers (two spare), constructed so as to work in combination with destructor furnaces, and also so as to work with coal and refuse together or, if necessary, with coal alone, each boiler to be capable of evaporating 2,500lb. of water per hour from 212deg. F.; economiser; feed-water heaters; feed-pumps and water service in duplicate; steam and exhaust pipes (in boiler-house only); water-tanks; foundations, setting and fixing of above...	£23,260
Engine-room and offices	5,000
Three steam flywheel alternators, each of a capacity of 200 units (one spare); overhead travelling crane; one steam alternator of 100 units (for day load); two steam exciters (one spare); two arc-light steam generators (one spare), each with a capacity of 60 units; switchboards and instruments; engine-room fittings; duplicate system of steam and exhaust pipes and valves	25,370
Eight miles of high-tension feeders; 24 miles of low-tension distributing mains; 13 miles 4in. cast-iron pipe and requisite surface and connecting boxes; trenching and making good eight miles of street; connections to consumers' houses; 16·5 miles of arc-light mains; 11 transformers of 35 units each; underground vaults or sub-stations for above	18,600
140 arc lamps and ornamental posts, fitted complete, with necessary switches and cut-outs; 140 joint boxes........	4,490
Site........................	3,000
Total	£79,720

ESTIMATE OF PROFIT AND LOSS.

Revenue.	£	s.	d.
Saved on collection and disposal of refuse	3,500	0	0
Present cost of gas-lighting in scheduled streets ...	519	0	0
Sale of 320,000 units for private lighting at 5d. per unit........................	6,666	13	4
	£10,685	13	4

Working Expenses	£	s.	d.
Cost of public lighting in scheduled streets...........	1,557	0	0
Cost of generating and distributing 320,000 units for private lighting: Fuel	200	0	0
Oil, waste, water and engine-room stores, at 0·6d. per unit	800	0	0
Salaries and wages, at 0·8d. per unit................	1,066	13	4
Repairs and maintenance, at 0·7d. per unit (exclusive of repairs to refuse destructor, which has been provided for in calculating cost of burning)	933	6	8
Management at 0·6 per unit	800	0	0
	£5,357	0	0
Revenue........................	£10,685	13	4
Working expenses	5,357	0	0
	£5,328	13	4

In the above estimates I have made no allowance whatever for any revenue that may be derived from the sale of mortar (which can be very economically manufactured from the clinker produced by the burning of the refuse), nor from current sold during the daytime for motive power, although it seems highly probable that if, as I should suggest, electricity be sold for 2½d. per unit during the daytime, there will be a demand for electric energy during the hours of daylight, and almost all the revenue that can be obtained in this way will be profit. The interest and sinking fund on the capital outlay which I have indicated will amount to about £4,000 per annum, leaving a clear net profit of about £1 328 a year, or a very possible net profit of nearly £2,000 a year, if there be, as I confidently anticipate, a fair demand for electrical energy during the daytime and if only a small amount of mortar be sold.

In conclusion, I would only say that I have given very liberal estimates of capital outlay and working expenses, and that I shall be disappointed if they are not appreciably reduced in practice, both with respect to the refuse destructor and to the electricity supply works. In calculating the capital outlay I have, of course, had in view a suitable site, but I have purposely made no mention of the locality for very obvious reasons. I have endeavoured to place this important matter before you fairly, temperately, and without bias; and if there is any further information which I can supply, I shall have great pleasure in affording it.

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TO CORRESPONDENTS.

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THE REGULATION OF ELECTRIC MOTORS.

There is always a right way and a wrong way of solving a problem, and it frequently happens that the wrong way is the more attractive as well as the more costly in the long run. The regulation of motors is the problem we have now before us, and the wrong method of doing this under discussion is Mr. H. Ward Leonard's system. This system was exploited some years ago, and was, we thought, sufficiently controverted at that time. We find, however, that the author has recently read a paper on the subject before the American Institute of Electrical Engineers, under the title "Volts *v.* Ohms." The speed regulation of electric motors is said to be the real subject of the investigation, but from the description we gather that it is rather that of starting a motor economically. The well-used method of inserting a resistance in the armature circuit is, of course, a wasteful method, as at the instant of starting a very large proportion of the power taken from the circuit is wasted in heat. If, however, the motor is to run continuously, the power so wasted is only a small proportion of the total. Now, Mr. Leonard's method involves the use of at least one motor and one dynamo beside the motor to be controlled. The first motor is shunt wound, and placed across the supply main. It then drives the auxiliary dynamo, which also has its shunt across the main, with an extra large shunt rheostat in the circuit. The leads from this dynamo are connected to the active motor, which is also constantly excited by a shunt from the mains. The arrangement then is worked as follows. At one-tenth of the normal speed only one-tenth of the voltage is required to give full load torque in the active motor. As the field of this motor is constant, the current required is practically full-load current. Instead of getting this reduced pressure by added resistance, Mr. Leonard gets it by transformation. He weakens the field of the auxiliary dynamo to about one-tenth of its normal value, so that it may give the pressure required. In this way only the energy required to start the machinery is taken from the main, plus the loss in transformation. The author of the paper discusses the efficiency and stability of the above arrangement at one-tenth speed, and naturally it compares favourably with the resistance starting apparatus. There is one fact he does not mention, and that is, that the commutator of a dynamo running at full current with one-tenth of the normal strength of field gives off light and heat to an alarming extent. In fact, it is utterly impracticable to run a machine in this way for more than a few seconds at a time. So, as a means of speed regulation with wide limit, the method fails from the fact that the dynamo would depreciate too rapidly. For smaller variations in speed the method would doubtless be applicable, but then the question of cost comes in. To apply the matter practically, three machines are required of at least equal output to that of the active motor. Certainly Mr. Leonard shows an arrangement in his paper by which the motor-generator machines need only be of half this output, but then the connection necessitates at half-speed, of

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the dynamo, passing the full current through its armature, while the magnets are not excited at all. Hence the sparking difficulties preclude this economy in machinery. The consumer who spends, say, eighty pounds for his motor will therefore require to spend at least one hundred and sixty pounds to be able to regulate the speed of this motor, and then the appliance gives larger ranges of speed. Almost equally good results can be obtained by using a shunt motor with extra heavy field magnets and reducing the speed by increasing the strength of field. This will also increase the first cost, but the increment will be small compared to the above arrangement. Where a variation of speed is required for a considerable time, as in driving shop tools, no electrical method can replace the speed pulleys almost universally adopted, although electric means can give fine adjustments for speed between the steps on the pulleys. We wait with curiosity a report of the discussion on the above paper.

ARE CENTRAL STATIONS DOOMED ?

This is a conundrum put by Max Osterberg in the American *Engineering Magazine*. We are not good hands at solving conundrums, so were pleased to find the author had solved the question—to his own satisfaction, if not to that of other people. He concludes, for various reasons set forth, that isolated plants will supersede central stations. This may be so in America, but in Britain the fashion has set in the other way, and many isolated plants are being sold, current being obtained from the central station. Of course, that fact may point to the ultimate suppression of central stations, but the fashion must change first, and, so far as we can see, the only valid reason for such supervision is that fashions do change. Look at bonnets, forsooth. Fashion, then, is like the wind—very fickle. But, after all, Mr. Max Osterberg does not leave central-station engineers without a crumb of comfort, for he admits that a good deal depends upon "commercial considerations." Those at present in Britain tend to make us believers in central stations, and we live in hope that Mr. Osterberg may become a convert to centralisation even in America.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

MOTORCARS.

SIR,—I observe that it is proposed to have a motor Derby. To this none can have any objection. It is merely a question for those who run in the race to consider how far they care to risk their lives with no compensating advantage.

But in the announcement the following words occur: "The committee will require a special ground . . . . at least a full level and straight mile." Elsewhere there appears the following: "But the principal point will be speed, which we are of opinion forms the most satisfactory test as to the excellence of construction of the mechanical vehicle."

In these two quotations lie the danger of the proposed race, so far as the public safety and the pockets of purchasers are concerned.

The Local Government Board, in order to meet the desire of the local authorities to limit the speed, have fixed 12 miles an hour for the maximum, and the Act itself permits no rate beyond 14 miles an hour, and no one can hold out the smallest probability that this rate of speed will be increased in any future Act. Therefore any attempt to place self-propelled vehicles on the market capable of making a pace much greater than that permitted by law will simply act as an incentive to their owners to do that which is forbidden when hurrying to keep an appointment for which they are late.

But the worst feature in the announcement is the statement that speed is the best test for a carriage, because a level track is to be selected for the trial. Experts know perfectly well that the power required to propel a light motor carriage on the level when the road is good is exceedingly small, while such a carriage on an incline might be a complete failure for want of sufficient power. No test could be more delusive than the one suggested. It would place the present petroleum-motor carriage on a par with steam, whereas on meeting an incline the steam carriage would in a few moments be out of sight, whilst the petroleum-driven one was struggling to climb the hill. This I can vouch for from what I have seen in connection with motor carriages and those in my possession, as well as from theory.

It is not fair that the public should be drawn into the net of company promoters by being made to believe that the proposed test is likely in any way to produce a satisfactory vehicle. Anyone who purchased a carriage based on such a notion would soon regret his bargain.—Yours, etc., DAVID L. SALOMONS.

PATENT OFFICE MUSEUM.

SIR,—Some of your readers are aware that a committee has been formed to promote a national museum, in which examples of railway practice may be preserved in addition to the few now shown in the exhibition galleries at South Kensington. At the same place there are a number of models of great interest to engineers—civil, mechanical, hydraulic, and electrical—as well as to inventors generally, and many of these were transferred to the Science and Art Department from the old Patent Museum by the Patents, Designs, and Trade Marks Act of 1883. While the Patent Museum was at the so-called "Brompton Boilers," the exhibits were not only open free each day to the public, but also until 10 o'clock at night for three nights in the week, and it was a most valuable and interesting collection. But since its transfer to the western side of Exhibition-road—a less convenient spot for most of its former visitors—it has not been opened at night until April last, and consequently much of its former usefulness has been impaired.

My purpose in writing is to ask your assistance in re-establishing the Patent Museum, but this time at the Patent Office itself, so that it may be in a more central and accessible spot, and be supplemental, as it were, to the most valuable and accessible technical library in the country. If the models and exhibits referred to were removed to Southampton-buildings, their place at South Kensington could readily be filled with the railway relics aforesaid, so that the two projects are of mutual assistance. But, in addition to the old collection, new models and new materials, illustrative of modern progress, should be provided from time to time, and these as far as possible should be substantial enough to be freely handled. The usefulness of such a museum at such a place is obvious.

It is not generally known that the cost of building large extensions to the Patent Office, now in progress, is provided for out of the annual surplus of the Patent Office. In 1895 that surplus was £96,500, out of which £10,160 was expended in connection with these extensions, and the Government are about to obtain power to acquire more property. Is this not a fitting time, Sir, to urge upon the Board of Trade the re-establishment of a patent museum and have not inventors a prior claim upon, say, £5,000 a year of this surplus to meet its cost? It might be, and should be, made the finest technical museum in the

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country; and in these days of foreign competition we cannot afford to lose any opportunity of teaching and guiding our inventors and others interested along scientific paths, and inciting them by the ingenuity of their predecessors.—Yours, etc., J. SINCLAIR FAIRFAX.

REVIEWS.

Carriages Without Horses Shall Go. By A. R. SENNETT, A.M.I.C.E., etc. Illustrated. Whittaker and Co. Price 2s.

Auto-Cars. By D. FARMAN, M.I.E.E. Translated from the French by LUCIEN SERRAILLIER; with Preface by Baron NYEVELT. Illustrated.

We cannot enter into detailed criticism upon these works, because they are so evidently books of the moment that a discussion of permanent value would be wasted. The motorcar boom—as senseless and idiotic as most of the company-promoter booms are—may perhaps do a little good in one way, by inducing a larger or smaller number of the public to seek for information of a particular character. To meet this demand the books before us have been issued. Mr. Sennett's is a reprint, with appendices added, of his British Association paper. It is practically a brief historical sketch of the subject, with necessarily much history left out. Such a book fulfils its object, but must not be taken too seriously. So far as we can see, the author assumes that vehicular reform is upon us. On the contrary, we imagine much will have to be done before mechanical takes the place of horse traction. A few hobbyists will ride their hobby to death and pave the way by experiment and experience for something which will supersede animal traction. We must have propagandists, and in this light welcome Mr. Sennett's production, his energetic pushing of his views, his attempts to educate the public mind; and we trust that he will garner some fruit for his pains.

The second book is somewhat more ambitious in character, but, again, it must be classed among those destined to fill a momentary void. We must emphatically protest against such calculations as are given on pp. 64-5-6-7. If such figures are to be given, they should be from well-ascertained facts, from the published documents of public companies, and not estimates. Figures from any books of this kind will be used to induce people ignorant of the subject to invest money which ought not to be invested. So far as pages of theory, so far as descriptions of various forms of motors and of cars are concerned, give them by all means; make the matter as detailed as possible, but eschew the £ s. d. of working expenses. Neither author, translator, or introduction writer knows with any exactitude the costs as will accrue in ordinary road traction. Leaving this point out, the book certainly provides a mass of information of a very useful nature.

ON THE MANUFACTURE OF ALKALI AND BLEACH BY CHEMICAL AND ELECTROLYTICAL METHODS.*

BY BERTRAM BLOUNT, F.I.C., F.C.S., A.M.I.C.E.

There is an unceasing demand—and one, moreover, which is not likely to determine, or even abate, as long as our present concept of civilisation endures—for those products obtainable from salt as a raw material which we include by means of the terms alkali and bleach. Viewing the stupendous quantities of all forms of alkali, soda ash, caustic soda, soda crystals, and bicarbonate of soda and of bleach as powder, or in solution as bleaching liquor, which are prepared for the market, it is not easy to understand in what way and in what directions absorptions of these products can occur. It would doubtless be interesting to trace a few typical hundredweight of each material from the works to its far-away goal—the common sewer; but the enquiry is not sufficiently within our present scope to merit close prosecution, and is too complex and ramified to be dismissed in a paragraph. It is sufficient to realise that the demand exists and is likely to continue.

But although there is a steady and, as far as conceivable, a permanent demand, yet it is not voracious or indiscriminate. Goods to sell must either be good or cheap—preferably both good and cheap. Neither will the market take any account of the ingenuity of contrivance which has led to the production of a given commodity. It is concerned solely with the nature and quality of the commodity and with its price. It follows that a process to be successful in the commercial sense of being remunerative must be capable of preparing either a better product at the same rate or the same product at a cheaper rate before it can hope to be shown any preference over older and better established processes. It matters not a halfpenny to the consumer what elegant principles are illustrated by the process used to supply him with the materials which he requires; he looks only to the stuff and its price—very often indeed only to the price; if his regard wanders further afield it is more likely to light upon the drum in which the material is packed than upon the scientific subtleties whereby the drum has been filled.

I have not said this in praise or condemnation of the consumer; the discussion of ethical questions is altogether foreign to my purpose. I am merely concerned to inculcate this one fact—obvious indeed, but constantly forgotten—viz., that no beauty of principle or execution can save a process which does not pay, and that no faultiness of design or performance can expunge one which does. This clearing of the ground is particularly necessary when considering the present situation of the trade in alkali and bleach and the tendencies, latent or patent, which may eventually or will actually shift its centre of gravity from the chemical to the electrical side. On the face of it, the extant chemical methods of manufacture are roundabout and clumsy, while the processes dependent on the use of electrical energy are singularly simple and direct. As long as zinc was the sole available fuel for the production of electrical energy, chemical methods for obtaining any material, the conjoint reactions for the synthesis of which were endothemic, held the field without possibility of rivalry. With the advent of an efficient dynamo the conditions of competition were radically changed. In spite of the large loss, computed by the ingenious at 90 per cent. or more, which the energy of coal undergoes before it can be delivered as current at the terminals of an electrolytic cell, the cost of a given quantity of electrical energy is no longer so great as to make electrical methods unthinkable when compared with the direct (but wasteful) application of energy as heat by the combustion of fuel in processes that are definitely chemical. It must be remembered that elaborate determinations—thanks, chiefly, to the zeal of engineers intent on improving prime movers—of the total loss from boiler furnace to crankshaft have been repeatedly made, and that every layman of intelligence is aware of the wastefulness of these intermediaries; whereas, on the other hand, the quantity of heat going up the chimney in the simplest furnace operation has either not been computed or, if computed, is not a matter of common knowledge. Thus in the distillation of zinc the energy required to be supplied from the furnace for the reduction of ZnO to Zn (in gramme equivalents) is 56 cal., but the actual quantity needed is at least 5,200 cal., involving the consumption of 10lb. of coal per pound of zinc, or more than 90 times the calculated minimum quantity. It may therefore be feasible to adopt a process admittedly using energy in a costly form in preference to one capable of being performed by energy in a cheap form such as direct heat, if the former be directed with such nicety that the energy is less wastefully employed. A comparison of the energy required for the conversion of common salt into the products NaOH and Cl by the Leblanc process and by any one of the moderately efficient electrolytic processes now seeking a footing may prove instructive. In making this comparison I have avoided stating the quantities of heat theoretically necessary for the several reactions, as these quantities bear but a remote relation to those which are actually required. Thus in the preparation of salt cake (the first step in the Leblanc process), although the reaction represented by the equation

$$2NaCl + H_2SO_4 = Na_2SO_4 + 2HCl$$

needs but a small access of heat for its completion, yet in practice it requires a considerable consumption of coal to bring it about. It will therefore be of greater utility to take as a basis of comparison the fuel found by the actual needs of manufacture to be required for each stage under consideration. In making salt cake by the action of sulphuric acid on salt, about ·3 to ·5 ton of coal is needed for the production of one ton of salt cake. The surplus heat from the combustion of this fuel either escapes with the flue gases or is carried off by the vapour of hydrochloric acid, which has to be cooled, condensed, and collected by absorption in water, its energy existing as sensible and latent heat being communicated to the condensing and cooling water. In the next stage—the black-ash process—the consumption of fuel is ·7 to 1·0 per ton of salt cake, reckoning in both that used for heating the furnace and that for mixing with the charge. Of this quantity about ·3 ton is needed theoretically to bring about the reaction

$$Na_2SO_4 + 4C = 4CO + Na_2S$$

and in practice about ·4 to ·5 ton is used, leaving a balance of

* Paper read before the Northern Society of Electrical Engineers, December 7, 1896.

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·3 to ·5 ton consumed in the furnace to produce sensible heat and to cause the reaction to take place.

This liberal expenditure is less lavish than it seems, because the waste of the black-ash furnaces is used to boil down the tank liquor (obtained by the lixiviation of the black ash). Nevertheless the expenditure is large, and in the end leaves the soda ash rather worse off, from an energy point of view, than it was at the beginning, inasmuch as the "black salt" (the product of lixiviation) contains a molecule of water which has to be driven off by calcination, involving the consumption of about ·4 ton of coal per ton of soda ash—*i.e.*, about ·3 ton per ton of salt cake originally charged. We are now in a position to sum up roughly the quantity of fuel required to produce one ton of soda ash by the Leblanc process carried out with neither unusual waste nor special economy.

Consumption of Coal per ton of Salt Cake.

	Ton.
In salt-cake furnace	0·4
In black-ash furnace	0·8
In finishing furnace	0·3
	1·5
i.e., per ton of soda ash	2·0 tons.

Seeing that there is always a sensible loss of soda (15 to 20 per cent.) in the process of passing from Na_2SO_4 to Na_2CO_3, this consumption of coal is rather an understatement than the reverse.

In preparing caustic soda from the soda ash made in this manner a further quantity of fuel will be requisite, both for burning the lime needed as a causticising agent and for boiling down the caustic liquor. As surplus heat from the black-ash furnaces is used for a part of the causticising process the quantity of additional fuel is difficult to compute, but if the total amount (including that needed for burning the lime) be put down at ·2 ton per ton of caustic soda produced the estimate will not be excessive. This corresponds with about ·1 ton of coal reckoned on the original salt cake, and the total consumption of fuel for the production of one ton of 77 per cent. caustic may be set down with an approximation sufficient for our present purpose at 2·8 tons. A corresponding estimate of the cost of fuel needed to produce one ton of sodium carbonate or one ton of caustic soda by any modern electrolytic process may be usefully made. Assuming that one horse-power hour can be obtained by the consumption of 2lb. of coal, using modern boilers and engines of good design, and that four-fifths of the energy developed in the engine is available at the terminals of an electrolytic cell, and, further, taking the average working voltage of the cell at four volts, it appears that the consumption of coal necessary for the production of one ton of caustic soda, including that necessary for concentrating the alkaline lye obtained as the immediate product of electrolysis, is 4·2 tons, and that needed for the production of one ton of sodium carbonate may be stated at 3·3 tons, quantities greater certainly than those needed for the Leblanc process, but of the same order of magnitude. But by the electrolytic process, as usually conducted, an amount of chlorine approximately equivalent to that of the caustic soda produced is evolved at the anode.

The energy expended in the production of caustic soda also suffices for the generation of chlorine, and no further quantity of fuel has to be debited against the process. But in obtaining chlorine by the Leblanc process a certain further expenditure of fuel is inevitable. The chlorine appears in the form of hydrochloric acid, and is usually worked up by the Weldon process. In this, which involves heating the chlorine stills, heating the purified still liquor mixed with lime, and blowing in large volumes of air to reoxidise the manganous oxide (all processes needing fuel) a considerable consumption of coal occurs. Similarly in the Deacon process, which uses the hydrochloric acid as gas without condensation in water, heating the air needed to oxidise the gaseous hydrochloric acid is requisite, and in all about one ton of coal is needed for one ton of bleach produced, or, in round numbers, three tons of coal per ton of chlorine, or 2·6 tons of coal per ton of caustic soda. Thus the total consumption of fuel for the production of one ton of caustic soda and its equivalent amount of chlorine rises to 5·4 tons; similarly, for one ton of sodium carbonate and its equivalent of chlorine about four tons of fuel will be required. These figures are to be compared with the corresponding values 4·2 and 3·3 tons for the same products prepared electrolytically.

In the above comparison no pretension to exactitude is made, inasmuch as accurate data are not readily accessible and the consumption of fuel will vary largely according to the practice of each works and the degree of efficiency of the plant and staff, but enough has been said to make it clear that the consumption of fuel by the two methods is not dissimilar, and that on the present basis for the production of electrical energy no great advantage accruing from the saving of coal is to be credited to the electrolytic process. But although it is a comparatively simple matter to arrive at a decision as to the consumption of energy by each of the two typical processes it must not be supposed that decision between them can be based on this computation alone. In all enquiries of the kind it is necessary to preserve the most rigid distinction between the cost of a given operation in energy and in money. These are incommensurable quantities for the adequate reason that the energy cost of a given product is the inevitable outcome of physical facts, while the money cost of a given product is purely no expression of its particular power of appeal to some need, psychical or physical, of human beings. Whence it is clear that a 50-carat diamond, which is energetically inconsiderable when matched with a ton of anthracite, is pecuniarily to be preferred thereto, because it appeals successfully to certain instincts indigenous in barbarous humanity.

If, then, we dismiss electrolytic processes as at present carried out as being to no great extent superior to existing chemical methods in their consumption of energy for a given output, on what ground, if any, are they to be preferred? The first is that no form of matter other than sodium chloride and water is necessary for the production of caustic soda and chlorine from brine, and that there is consequently no waste product. In the Leblanc process, on the other hand, sulphur and nitrate of soda (for the production of sulphuric acid) are needed in the very first stage—viz., the manufacture of salt cake. Of these the sulphur may be recovered by the Chance process, and the soda of the nitrate of soda may find its way into the salt-cake furnace, but the nitric acid is ultimately lost. Again, in the black ash process, the lime present after the completion of the process as calcium sulphide finally appears as a sludge of impure calcium carbonate in the waste from the Chance process. Attempts to utilise it as cement have been made, but, as far as I am aware, with very dubious success. In like manner the lime from the causticising of the soda ash is obtained as carbonate, and is substantially a waste product. Similarly, with regard to the working up of the hydrochloric acid for chlorine, one finds iron and similar impurities from the still liquors in the Weldon process, and calcium chloride after reoxidation and the production of Weldon mud to be disposed of as valueless materials. It must be remembered that these waste products not only mean cost in themselves, but also necessitate an expenditure, which is sometimes serious, in handling and removing them. In the electrolytic process, on the other hand, nothing but finished products should need to be conveyed from the works. The only by-product (hydrogen, appearing at the cathode together with caustic soda) can be trusted to effect its own removal if allowed access to the air.

The other respect in which an electrolytic process has an advantage over chemical methods of making alkali is in the saving of labour. This is to some extent an outcome of the freedom from the necessity for removing waste products spoken of above. Moreover, the material is handled in a liquid or gaseous form throughout the process, up to the point at which the caustic soda solution is boiled down for the production of solid caustic. There is nothing corresponding with the loading-in of salt to the salt-cake furnace and the removal of the salt cake therefrom, nor of the similar proceedings necessary at the black ash stage. In these days, when the manual worker is apt to be exigent, any process which tends towards his deletion has a commercial advantage over those of its competitors which depend upon his aid. It is not merely a diminution of running expenses which may be secured—it is the freedom from the fear of a disastrous stoppage of the whole works which makes labour-saving methods and appliances attractive to the manufacturer. On the contrary side must be set the comparatively high cost of an electrolytic installation and its high rate of depreciation. Seeing that it is impracticable to use more than a very moderate current density at the electrodes of a cell in which a solution of salt is being decomposed, it is requisite to have a large number of cells for even a moderate output; thus the cost of the plant per ton of material produced per day is high. Further, the permanence of such forms of decomposing cell as have been devised hitherto is not very great. Diaphragms and anodes suffer electrolysis as well as does the intended electrolyte. A porous septum which shall have a reasonably low resistance and shall nevertheless keep the products of electrolysis fairly well apart is difficult to design, and complete success has not yet attended the efforts of inventors in this direction.

(*To be continued.*)

GLASGOW CORPORATION TRAMWAYS REPORT.

The following is a condensation of a report by the general manager and engineer of Glasgow on tramway traction and operation in American cities:

In accordance with instructions, we have visited America and investigated the various forms of tramway traction. We sailed from Liverpool on September 19, and after seven weeks' absence arrived home on November 7. The places we visited in pursuance of our investigation embraced the following: New York, Brooklyn, Jersey City, Staten Island, Philadelphia, Baltimore, Washington

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Pittsburg, Cincinnati, Chicago, Detroit, Cleveland, Buffalo, Niagara, Toronto, Montreal, and Boston. In all these places we had the pleasure of meeting the leading street railway men. We also saw the mayors of some of the most important cities, and visited the works of the principal manufacturers of street railway equipments. We desire to place on record our high appreciation of, and hearty thanks for, the courtesy and kindness shown to us by one and all of the many gentlemen in all these connections whom we had the pleasure of meeting in America. They all did their best to make our visit pleasant as well as instructive and useful. We took it as a compliment, not so much to ourselves as to the old country, and specially to the city of Glasgow, on whose behalf we were collecting information. We shall not be redeeming our promises if we do not heartily embrace every opportunity which presents itself of returning the compliment.

In America tramways are universally styled street railways, and the overhead electric system is usually spoken of as the trolley system. It will also be understood in this report that miles of track means single track where double track is not specially mentioned. Operating expenses per car mile are, as a rule, given exclusive of interest and municipal taxes, which usually include all payments in connection with the franchise or the right to construct and operate.

The authors proceed to give details of the equipment in the various towns mentioned above, and then proceed to draw conclusions as follows :

General Remarks and Conclusions.

It is about the lifetime of one generation since tramways or street railways became recognised as a necessity of city life. Ten years ago, with the exception of a few cables in San Francisco and Chicago, horse traction was universal. Wonderful changes have taken place since then. Many forms of traction have taken the field, and there has been a fierce and continuous struggle for the supremacy. One outcome of all this has been enormous development. In 1890 (not to go further back) there were 9,037 miles of street railways in the United States ; 5,400 miles were operated by horses, 510 miles by cable, 604 miles by steam, and 2,523 miles by electricity. The return for 1896 shows that they have increased to 15,956 miles, of which 1,351 miles were operated by horses, 612 miles by cable, 384 miles by steam, and 13,609 miles by electricity. Within the last five years the number of horses used in operating tramways in America has declined by no less than 80 per cent. Without waiting to trace the history of the traction struggle we shall endeavour to refer to and discuss the different forms of traction brought under our notice on this visit. They have practically all been discussed in former reports already in your hands, but we shall speak of them as seen and judged of in America.

Storage Batteries.—This system was tried some years ago in Washington, among other places. After a large amount of money had been expended on experiments the system was given up as a failure.

Oil and Gas Motors.—Mr. Yerkes, of Chicago, was at great trouble and expense testing the Connelly motors, but they proved unsuccessful, as well as unpopular, and he threw them aside. This is the system which your sub-committee inspected at Croydon. So far as we could learn, there are no other oil or gas motors in America.

Compressed Air.—Mr. Hardie has been working on compressed-air motors for some years, and has three of his cars now running in New York. They cannot be said, however, to be either sufficiently successful or popular to be seriously considered for adoption at present.

The latest compressed-air motor which has been brought out—and it has been done with a considerable show of influence—is one patented by Mr. Knight and Mr. Whitney. The former was one of the patentees of the Bentley-Knight conduit system, and the latter is largely interested in street railways. The first of the Knight-Whitney cars was placed on the Lennox-avenue route during our visit, and we had the pleasure of riding on it with Mr. Knight. All we can say is that the car seemed to run all right throughout the double journey (fully five miles) with one charge. But it would be rash to express an opinion regarding the future of anything of this kind in its first experimental stage, although it seemed to us the best compressed-air system yet produced.

Electromagnetic Systems.—Closed-conduit or magnetic systems have as yet made no headway in America, nor, as far as we could learn, are they looked upon with much favour or hope of practical success. In point of fact, so far as we are aware, no street railway company is at present even experimenting with them.

Electric Open-Conduit or Underground Systems.—Electric open-conduit installations—modifications of Siemens and Halske's Budapest system—have recently been put down, and are being experimented with in Washington and New York. In both cities the overhead system is forbidden. The two experiments are closely allied, and differ only in details. The slot, instead of being in the side rail as in Budapest, is in a third rail in the centre of the track, similar to the ordinary slot for the cable gripper. In Lennox-avenue, New York, the conductors in the conduit are of channel iron for one portion, and 1¼in. steam-tubes for another, while in Washington it is T-iron. The cost of construction is spoken of in America as practically prohibitory, and the special work at junctions and crossings is very expensive, one junction in New York having cost £15,000. In Washington the capital outlay for track and equipment is given at about £20,000 per mile of single line, and in New York the track alone is said to have cost that amount ; and, of course, the horse track and the asset it represents are wiped out. Last winter there was little frost or snow, so that these underground experiments have not been tested through a severe winter. Both in Washington and New York the cars have been stopped for a short time during heavy rains, but while we saw them in dry weather they were running very well and seemed nicer to ride in than the cable cars, and were evidently more popular. One drawback specially spoken of in connection with the operating of the underground system is the great difficulty of locating the defect when anything is wrong. And, of course, apart from snowstorms, there is the difficulty in wet weather of efficient insulation through damp and slush. We observed the electric lighting of the cars working on this system was not quite satisfactory. The lights were dim at times, and went out altogether at the junctions. The streets and climate of Washington are, no doubt, specially favourable for an underground system. Dry weather prevails ; the streets are wide, well formed, and clean : and on the underground routes there is practically no vehicular traffic heavier than buggies and bicycles. Lennox-avenue, New York, is also specially adapted for the system—long, straight lines, and a clean, wide street with only light traffic. The company who own this line and have been experimenting with the underground electric system are the same who have now begun to experiment with the latest compressed-air motor. Evidently they are not so satisfied with the results of the underground experiments as to justify them in proceeding further in that direction at present. They consider the cost of construction prohibitive, and have recently cancelled contracts made in connection with proposed extensions of the electric underground system, just as they had done previously with contracts for cable extension. A short length of the "Love" electric conduit system is still operating in Washington, but a similar experiment has been abandoned in Chicago. As mentioned in our notes under the heading of "Washington," the chief difference between the "Love" and the other underground electric systems is that it has a rolling contact, whereas the others have a sliding contact. Were money no object, and financial results not to be reckoned, an underground electric system can, in a dry climate, be operated where there is sufficient depth (over 2ft.) to construct a conduit. But it seems very doubtful indeed if, for a city and suburban system, even where that depth can be got, it could be made a commercial success, and all the more so in a damp climate like ours. It is well known that the Central Railway construction has made it impracticable to have this system in Argyle-street. On the merits and demerits of the open conduit we have learned nothing which casts the slightest doubt on the thorough soundness of Mr. Arnot's views as expressed in your sub-committee's Continental report. And in any case, with our prsent knowledge, we could not see our way to recommend the spending of money in entirely throwing away the present tramways and the assets represented by them ; and constructing an underground system, which is of necessity so expensive to construct, does not admit of general application to all lines of the system, and is only in the experimental stage, both commercially and from the operating point of view, more especially if there is a proved system which is satisfactory and admits of utilising the present road bed and is cheaper in every way. We feel bound always to bear in mind that the Glasgow Corporation tramways have no rating powers to fall back upon.

Cable System.—The cable system in the earlier days promised to be largely employed in street railways. However, one cannot pass with open eyes and ears through the cities of America without being thoroughly satisfied that it has been superseded. The American street railway men, one and all, speak of it as a "back number." The practical proof of this is that many miles of cable lines have been thrown out in such cities as Philadelphia, Baltimore, Pittsburgh, St. Louis, and even in San Francisco, the home of the cable system. We ourselves saw miles of cable conduits being taken up, and the tracks being reconstructed in every case for the electric overhead system. We also saw a few first-rate cable lines in the United States which are not likely to be disturbed in the meantime. The most notable of these are the trunk lines in New York, Chicago, and Washington. The New York authorities meantime forbid the overhead trolley system, and cables have, at an enormous cost, been put down in some of the busiest thoroughfares, including Broadway, which has the very busiest street railway in existence. They are all working satisfactorily and successfully, but the management make no secret of their preference for the overhead electric system—if they could get it. In like manner, cable lines are running very successfully in Chicago, in such busy thoroughfares as State street and Wabash-avenue—ideal cable routes—as also in the main arteries of a few other cities. In all such cases, however, the cables occupy the trunk lines—corresponding to our Argyle and Renfield streets—and no fair comparison can be made of the operating of such routes and the outside routes which feed them. On the average routes the cable system is more expensive than the overhead electric, and is considered rigid and cumbrous by comparison. There is no probability of the cable system being extended in any of the cities. On the contrary, there is a probability that when the construction or equipment requires renewal this system will give place to the more flexible and popular trolley.

Electric Overhead or Trolley System.—This is now undoubtedly the standard system of tramway traction in America. This is borne out by our notes in the various cities visited, and even more strongly by the actual facts. The invention of a patentee may, on its first appearance, be more or less successfully launched according to the backing it receives from the interest or influence of men of means and position. But no such influence can permanently affect the survival of the fittest. We cannot and need not say anything about the future. But up to the present time there is no difficulty

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whatever in making-up one's mind as to the best surviving and fittest form of street railway traction in America. Street railway managers and engineers have only one answer to the question, From your experience, and taking both efficiency and economy into account, what is the best form of tramway traction for Glasgow to adopt instead of horses? With unanimous voice they answer: the trolley. Each of the patentees and owners of other systems only claims that his system is the best where the trolley is prohibited. And at home we have heard the admission made that the reason why they don't want us to begin with a section of the overhead system is because they are convinced that if we began with it we would have nothing else.

Electricity has undoubtedly played the leading part in developing street railways in America. The trolley system was only introduced some eight or nine years ago, and since then the mileage of the American street railways has been practically doubled, and at the present time no less than 85 per cent. of the total mileage is operated by the trolley, and the percentage is daily increasing. The system had undoubtedly a crude beginning. In a new country all railroads and street railways must of necessity be constructed in the readiest and cheapest way possible. When the district traversed comes to be more settled and populous there is, of course, so much more money and traffic as to admit of a more permanent construction. Horse tramways were, as a rule, in America first laid down in very temporary fashion. Light rails were simply laid on cross ties or sleepers, to which they were spiked, and the ground levelled up or roughly paved, as the case might be. These rails carried the small horse cars in a way, but were totally insufficient to carry the heavier electrical cars at the higher rate of speed. When, therefore, electrical cars were introduced, the whole track had to be thrown out and laid with much heavier rails on a much stronger foundation. In early examples of the electric system the appearance of the overhead construction does not seem to have entered into the minds or calculations of the constructors. This is not to be wondered at. Their chief aim was rapid transit and development. And they were accustomed to seeing the obtrusive wooden telegraph poles on the sides of their streets carrying the telegraph wires, and, later, similar poles carrying the telephone wires in rapidly-increasing numbers. The side poles necessary to carry the cross-wires for the trolley were insignificant and beautiful by comparison, and so they stuck them up as fast as they could. The people got rapid transit and were delighted. Meantime, in some of the leading cities the appearance of the crude telegraph and telephone poles, and the innumerable wires they now carry, roused the municipal authorities. This was especially the case in New York City — the same city which had sanctioned elevated railways over their streets, which for ugliness have no rival. Whatever they may think of their elevated railroads, they were undoubtedly right in abolishing the huge wooden telegraph and telephone poles, which even yet disfigure most American cities. In many cases State or municipal ordinances have been passed requiring that in five years all telephone wires within certain areas shall be placed in ducts underground. Thus the objectionable poles have disappeared in New York, and are disappearing also in Washington, Boston, Chicago, etc. And no doubt all the chief cities will see it to be their credit to remove these eyesores. New York has evidently gone off to the other extreme, and will allow no overhead wires whatever. Washington has taken the same position, although the capital has still a good many of the old telegraph poles in her principal avenues. Chicago for a time declined to sanction the trolley system down town, but on the pressure of her own ratepayers the municipality is relenting, and very soon, according to Mayor Swift, the up-town trolleys will run right into the centre of the city. The Commissioners of the district of Columbia have also forbidden the introduction of the trolley system into Washington. We need scarcely refer to Washington in this connection, however, as it is a place by itself, and has little or nothing in common with a busy commercial city. With these exceptions every city in America has got, and is well served by, the trolley system, and in no case has the overhead system, when once introduced, ever been abandoned.

After seeing the best overhead construction for the electric overhead system, and considering its vast importance as a means of rapid transit of passengers on city and suburban streets and roads, we are perfectly reconciled to it, and feel that it only wants to be seen in use to be appreciated. Boston seems second to no city in her wish to regard her amenity, and Boston has the trolley everywhere. Mayor Quincey gave us freely his views on the overhead system from his point of view as representing the citizens, and they are in favour of the trolley, which during the last few years has done so much to develop the city. The city of Philadelphia ranks high among American cities. Mayor Warwick, of that city, was quite as frank and strong in his testimony in favour of the trolley, so general and popular in his city. It of course goes without saying that if a system as good and as cheap can be had without any overhead construction we should prefer it. But there is none such known at present. And we feel sure that if the citizens saw this system of rapid transit in operation on the Springburn route—comfortable cars, propelled, illuminated, and heated by the same power—they would not for a moment object to the appearance of neat poles to carry the wires, especially if the old lamp-posts were done away with, and the trolley poles made use of for electrically lighting the streets. We believe the citizens would soon conclude that it was beautiful as a whole.

Glasgow, as the commercial metropolis of Scotland, must continue to be a city of enterprise and industry. As such let us make it as artistic as we can. Is not the most beautiful ideal of an industrial city, however, one in which all classes of the citizens have decent houses to live in, as well as plenty of work by which they can earn sufficient money to meet their reasonable wants? These are the necessaries which make it possible for the individual members of an industrial community to live beautiful lives and build up beautiful characters. They must therefore occupy a foremost place in the city which is to be beautiful in the highest sense. Civilisation demands that the æsthetic gives place in many instances to the useful. We never were prouder of Glasgow than when we heard of the high place assigned to her as a municipality by the Americans. But we have not served 20 years in the Health Department, and been acquainted with "life in one room," without knowing Glasgow's blemishes—and they are common to all our older cities. One great city improvement scheme has been carried out in our city, and another is now being favourably considered. In Glasgow as it was five years ago there was a population of 565,714 on an area of 6,111 acres, giving 92 persons to the acre, or 58,800 to the square mile. In the present Greater Glasgow, apart from the adjoining but still separate burghs, we have a population of 705,000 on an area of 12,311 acres, giving 57 persons to the acre, or 36,480 to the square mile. When the four separate burghs now served by our tramway system are included we have a population of 841,000 persons on an area of 14,661 acres, which also gives 57 to the acre, or 36,480 to the square mile. No American city, with the exception of New York, is half so densely populated. No one wishes our citizens to continue so closely packed together as they now are. How are they to be spread out? In our humble opinion, and judging from what we have been privileged to see in America, the most powerful instrument which lies to the hand of the municipality for effecting this purpose is the best and cheapest possible tramway service radiating from the centre of the city outwards in every direction.

Such a system must be safe, rapid as far as consistent with safety, elastic as to speed, clean, comfortable, and attractive, flexible enough to apply to all routes and contingencies of street traffic, and, of course, as cheap as possible; and it would be all the better if each route had its suburban attractions in the shape of a park for music, and the usual facilities for amusement and recreation generally. As surely as you give cheap and rapid transit, which will enable all sorts and conditions of people living at a distance to travel comfortably to and from their work in the city, so surely will houses to accommodate them be built on cheaper ground—meaning cheaper rent—and with healthier surroundings. From all we have seen, we are of opinion that the overhead electric system of tramway traction reasonably fulfil these conditions. Its safety depends upon reasonable care and judgment as to speed and general working. There is practically no danger from the overhead wires, provided ordinary care is exercised in maintaining them properly. No man, so far as we could learn, has been killed by the current from the trolley wires. We have seen dozens of men who have had 500 to 600 volts without injury—in fact, almost every switchboard man has had it, some over and over again. They don't take it because they like it, but they have had it all the same. The president of the West End Company of Boston told us that they had comparatively more accidents with the horse cars than with the electric cars. If this can be said of the system in Boston, there is no reason why it should not apply to Glasgow, for Boston has the overhead system throughout, and down town the traffic is much more congested than in any part of Glasgow. The Mayor of Chicago expressed his opinion that the lieges in his city suffered more from bicycles than electric cars. Then the question of electrolysis is one which may freely be dismissed. We were well assured that by working to the Board of Trade regulations there can be no trouble in this connection. Under the rough-and ready way in which in the early days the trolley system was installed, it is no wonder that electrolysis resulted. The returns were very imperfect. Where the return is sufficient electrolysis is unknown. Where there have been indications of electrolytic action on gas or water pipes, engineers have had no difficulty in arresting it.

With regard to speed, the electric cars are under perfect control, and can run at any speed. There is no reason why on the average 50 per cent. should not be added to our time-table speed for horse traction.

The electric system is eminently flexible. The cars can be backed when necessary (which is not the case with the cable system), and they can easily be turned on to any route. And it is a system which admits of an easy extension of routes in longer or shorter stages as circumstances require. That an electrically-propelled car can be made clean, comfortable, and attractive by good seating, good lighting, and heating if necessary, is beyond a doubt, and these are very strong points in favour of electric traction. We believe that the poles, if of neat design and judiciously used for street-lighting, can be erected so as not to offend the eye. Where the buildings are continuous, the overhead construction is least noticed. If the cross-wires were fixed to the buildings, as in Hamburg, no poles would be necessary at such places, but it might look as well to have side poles throughout. That electric traction is cheap has also been clearly established, and all the more so when all that it fulfils is taken into account. So great and so general have been the changes in operating companies through amalgamation and consolidation that it is now almost impossible in very many cases to get from books or accounts exact figures bearing on the cost of operating by horses prior to the substitution of electric traction.

It may be remarked here that these changes have led in very many cases to over-capitalisation, chiefly through watering of stock. In a published table we have seen that in the case of one large company it takes no less than 58 per cent. of the total earnings to pay interest on capital liabilities. The published returns

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dealing with 15,425 miles of American street railways show that, over all, the capital stock and funded debt amount to £18,293 per mile of single track. In New York State the average is nearly double, being £36,560 per mile of single track. This may explain the reason why a large proportion of the street railway companies in America are not paying dividends. There is no doubt, however, that the companies who have conducted their business throughout on sound financial lines have, as a rule, very good properties at the present time. Although there was difficulty in getting comparative costs of operating in as many instances as we should have liked, we have given some good and reliable comparisons under the headings of the various cities. In addition to these, a deal of information regarding costs was given to us on the understanding that it was not for publication. These we have taken with the other to arrive at an average. Taking them on the average, the percentage of operating expenses to receipts with overhead electric traction in America is at least 15 per cent. less than with horse traction. The operating expenses per car per mile are, on the average, 2d. less than with horses. There are further financial gains to be taken into account. On the average, as compared with horse traction, the speed of the cars in America is accelerated by over 50 per cent., and the additional traffic developed by the substitution of electric traction has not been less on the average than 25 per cent.

It is true that the development which has taken place in Glasgow since July 1, 1894, may have made it impossible to realise such favourable results here, but we are confident that the results will be all in the same direction, even although the cost of conversion doubled our capital, as in Boston. No doubt it will be borne in mind that an object-lesson of 2½ miles cannot be expected to produce as good results as the operation on a large scale of an entire system. It should also be noted in this connection that Glasgow is much better served by city and suburban railways than are the American cities. The fare which is universal in America is five cents (2½d.) for any distance the car travels, and most companies also give free transfers to other routes in certain directions. A few companies sell discount tickets slightly reducing the five-cent fare. The Americans are quite astonished at our one-cent fare, and also that their minimum is practically our maximum. There are no cars—cable, electric, or horse—in America with top seats like ours, the obvious reason being the extremes of the climate. Seats on the roof of the car would be too hot in summer and too cold in winter. In most cases close cars are used in winter and open cars in summer. The adoption of the trolley does not interfere with the use of the top seats.

In the matter of organisation and management generally we did not consider America in advance of the old country. The cars in America do not carry half as many passengers per car mile as ours do in Glasgow. With regard to the permanent way, there are certainly some points in their track construction which we have very carefully noted, and particularly the rail welding, but, on the whole, there is scarcely a track up to the present time in America equal to what we have recently been putting down in Glasgow, and in very many cases electric cars are running in America on tracks very much inferior to the Glasgow horse tracks. American managers and engineers, while they smile at our still continuing to operate with horses, at the same time congratulate us on our having been able to wait. The pioneers of the electric overhead system have come through a trying and expensive experience. The first motors, generators, and equipments were crude, and had soon to be thrown aside in favour of newer designs. These also in their turn became obsolete. Even up till within the last two years great improvements were made, but now it is generally believed that engines and generators, motors and line equipments have all been by experience so much improved that now they are practically standardised, and they can undoubtedly be bought at very much less money than at any former time.

The adoption of large units from 1,000 h.p. to 2,000 h.p. has very considerably cheapened the cost of production and maintenance in the power station. Electric motors are not only immensely improved, but they now cost only about one-fourth of the price charged in the early days of electric traction, and all the latest electrical equipments are much reduced in price. The result of improved motors and equipments is that the cost of maintenance has been reduced from three cents per car mile to one cent. One of the greatest improvements has been in the controller. The series-parallel controller is now almost universally used in America. It not only enables the driver or motorman to regulate the speed to a nicety, but it is also fitted with a reversing arrangement by which he can not only back the car but can also cause the motors to act as an emergency brake should occasion arise. By its use there is also a great saving in current as compared with the rheostat formerly used.

Under these circumstances we feel that nothing has hitherto been lost by delay. We also believe that the time has now come when it is perfectly safe to make a move on a small scale, and are satisfied that the opportunities that have been given us for studying the whole question, both in Europe and in America, have brought our information so well up to date that we should have no difficulty in taking in hand to give an object-lesson on the Springburn route of which the citizens will not be ashamed. Although the question of alternating currents for longer distances is at present occupying a good deal of attention, we need not enter upon it here, as direct current would, in any event, be used for a short distance like the route to Springburn. The estimate already given of the cost of equipping the Springburn section on the basis of the present service, apart from any necessary renewal of rails, is £19,575, as detailed in last report by the sub-committee on mechanical traction.

RECOMMENDATION.

We therefore simply confirm the recommendation of the sub-committee as per their report on mechanical traction in Europe, dated July last, which reads as follows: "That, having carefully considered the whole question, we recommend that the route from Mitchell street to Springburn be equipped for overhead electric traction as indicated, and that with a view to providing in this way for the necessary augmentation of the service, which is sure to be required next spring, it be remitted to the Tramways Committee with powers to equip this route accordingly as soon as they conveniently can." And we make the further suggestion that the Corporation remit to the Electric Lighting Committee, acting in co-operation with the Tramways Committee, to light electrically as an experiment a portion of the route with a view to utilising the traction poles for lighting purposes.

LEGAL INTELLIGENCE.

OVERHEAD WIRES AT BRIGHTON.

A trunk line of telephonic communication is in course of erection between London and Brighton, and the Postmaster-General recently made application to the Brighton Corporation for permission to bring the line overhead into Brighton by way of Ditchling-road. The matter has been seriously considered by the Council, and at the last meeting the Works Committee brought forward a recommendation that the Council consent to the erection of overhead wires along the Ditchling-road, from the railway bridge to the boundary of the borough, on condition that no poles be placed upon the highway (except on such portions as are not enclosed by land occupied with buildings); that they be of approved design, and in approved positions, and that the Postmaster-General undertake to remove the same when the erection of houses renders the removal necessary in the Council's opinion. A letter was received from the Postmaster-General, however, intimating that he could not undertake to remove the poles upon the erection of houses.

The matter being thus at a deadlock, **Sir Robert Hunter**, solicitor to the General Post Office, made an application at the Brighton Borough Bench, on behalf of the Postmaster-General, for the stipendiary (Mr. C. G. Heathcote) to decide the matter by arbitration.

The case has already occupied two days, and was not concluded at the time of going to press.

"ELECTRICAL APPRENTICES."

At the Thames Police Court last week Samuel Fynn, electrician, of Commercial-road, was charged on remand with obtaining money by false pretences. The allegations against the prisoner were that he advertised for apprentices to be taught, for a premium, electrical engineering, but that he did practically no business, and that the lads were put to menial tasks, and learned absolutely nothing.

The defence was that the prisoner had been very unfortunate. When the boys were first taken by him he had a good business, but it had fallen off considerably. When the last execution was put in and he found that he could go on no longer, he had tried to have the indentures transferred to a well-known firm of electrical engineers.

Further evidence was given in support of the charge, and the case was again adjourned.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Bolton.—The Corporation require tenders for a new steam-boiler at the electricity works.

Strassburg.—December 16 is the date for tenders for the supply of 1,060 wooden telegraph poles to Elsass-Lothringen Railway Authorities.

Essen.—Among other articles for supply by tender to the Prussian State Railway Authorities at Essen on December 17 are 1,000 battery zincs.

Denton. — Specifications and tenders are invited for electric light installation. Apply to Messrs. John Lever and Co., galloon manufacturers, Denton.

Brussels.—Tenders will be received on December 24 at the Brussels Bourse for the supply of wooden telegraph poles for the Belgian telegraph service.

The Hague.—The Dutch Waterstaat Ministry want tenders on 18th inst. for the supply of zinc, iron, and copper stores for the telegraphic service in the forthcoming year.

Elberfeld.—Among other miscellaneous stores, tenders will be received at Elberfeld on December 30 for the supply of electric light carbons for the Prussian State Railway.

Breslau.—December 14 is the date for tenders at Breslau for the supply of telegraph poles to the Railway Telegraph Authorities. The office is Brüderstrasse 32, Breslau, and particulars are obtainable for 7½d.

Saint-Yvon (France).—Tenders will be wanted on January 31 for an electric lighting installation (to replace 1,500 gas lights) at

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the lunatic asylum at Saint-Yvon, in the Seine Inferieure. Application to the asylum authorities.

Madrid.—Tenders are wanted by December 16 for the supply of 20 tons of telegraph wire (copper) for the Government Telegraphs. Application should be made to la Dirección general de Correos y Telegrafos, Madrid, Calle de Carretas 10.

Kiel.—Tenders will be received on December 18 for the supply of iron, copper, bronze, and steel wire for the Imperial Dockyard. Particulars (price 7d.) from the Kaiserl. Werft Abtheilung für Verwaltungs Angelegenheiten, Kiel, Germany.

Karlsruhe.—Tenders will be received on January 2 next for an electric lighting installation for the railway station and pier at Constance for the Grand Ducal Railway Authorities. Particulars are obtainable for 10 marks (10s.) from the Generaldirektion, (Centralbureau) Grossh. Badischen, Staatseisenbahnen, Karlsruhe, Germany.

Harrogate.—The Town Council are prepared to receive tenders for wiring the Municipal Offices, Victoria Baths, Market Hall, and Public Library; also for electrical fittings for the same. Specifications and forms of tender can be obtained at the office of the Electrical Engineer, Montpellier-gardens. Tenders must be delivered on or before January 1, 1897. Further particulars appear in our advertisement columns.

Wakefield.—The Visiting Committee of the County Council invite tenders for the maintenance and renewal of the electrical recording stations, signals, bells, and telephones at the West Riding Asylum, Wakefield. For further particulars, form of tender, and instructions apply to Mr. J. S. Banks, clerk of works. Sealed tenders, properly endorsed, to be forwarded to Mr. J. Vickers Edwards, county surveyor, Wakefield, by December 14.

Camberwell (London).—The Baths Committee of the Vestry invite tenders for the renewal, etc., of 45 accumulators or storage batteries in connection with the electric lighting of their baths and wash-houses in Church-street. Tenders to be delivered on the 14th inst., not later than 4 o'clock in the afternoon. Full particulars from Mr. O. S. Brown, surveyor to the Vestry, Vestry Hall, Camberwell. Additional details are published in our advertisement columns.

Aberdeen.—The Corporation Gas and Electricity Works invite tenders for supplying the following articles for one year from January 1 to December 31, 1897: cast iron work; malleable iron and ironmongery; steel goods; brass, lead, and tin work; ropes, rope yarn, tow, etc.; painter and glazier's work; timber; carting, all according to schedules, which will be delivered to intending contractors at the Gas Engineer's Office, Cotton-street. Sealed tenders to be addressed to the Town Council, and, marked as such, to be delivered at the Gas Office, Board-street, Aberdeen, by 14th inst.

Colwyn Bay.—The Urban District Council invite plans, particulars, and estimates, etc., for a scheme of electric lighting for their district, the powers for which they obtained last session. To the author of the scheme considered the best a premium of £30 will be paid, and in the event of the work being carried out such premium must be considered as part payment of the engineer's commission. To the author of the scheme considered second best a premium of £20 will be paid. Further information will be received on personal application to Mr. Wm. Jones, A.M.I.C.E., the Council's surveyor. The schemes must be sent in not later than January 12, 1897. Further particulars are contained in an advertisement in another part of the paper.

Swansea.—Tenders are wanted for the entire construction and equipment of the Constitution Hill Tramway, Swansea. Plans may be seen and all particulars obtained at the offices of Mr. Charles T. Ruthen, C.E., 24, Goat-street, Swansea, engineer to undertaking, or at the offices of the consulting engineer, Mr. G. Croydon Marks, C.E., 18, Southampton-buildings, Chancery-lane, London, W.C. Specifications, forms of tender, etc., may be obtained from either of above upon payment of £5 (Bank of England note), which amount will be returned upon receipt of a bona fide tender. Tenders to be sent to the Proprietors, Constitution Hill Tramway, care of Messrs. Marks and Ruthen, 24, Goat-street, Swansea, by 10 a.m. on 16th inst.

London, N.—The Vestry of St. Mary, Islington, require tenders for the supply of machine tools, smiths' tools, and engineers' tools. Specification, conditions, and form of tender may be obtained on application on or before 14th inst. to the Electrical Engineer, 50, Eden-grove, Holloway, N. A deposit of £1. 1s. will be required, which will be returned on receipt of a bona fide tender. All tenders must be sent under cover, endorsed "Electricity Department, Tools," and addressed to Mr. Wm. F. Dewey, vestry clerk, Vestry Hall, Upper-street, N., and must be received not later than 12 noon on 16th inst. Persons tendering must annex to their tenders a schedule of wages relating to their trade, and will be required to make a declaration that they do and will, during the continuance of any contract they may enter into with the Vestry, continue to pay the trade union rate of wages, as in practice obtain, and observe the conditions and hours of labour prevalent among the several classes of labour they may employ.

RESULTS OF TENDERS.

Rangoon.—Mr. D. D. Coath's tender for a trial lighting of the main streets of Rangoon by electricity has been accepted at Rs.3,400 (nearly £200).

South Shields.—The Council have accepted Messrs. Ferranti's tender for the extension of plant required—viz., steam alternator and transformers, £5,412. 10s.; also rectifier and switchboard, £589.

Hanover.—Twelve firms tendered for the supply of telegraph posts to the German State Railways. The prices vary, according to the place of delivery and quantities, from an equivalent of 10s. 6d. to 1s. 4d. each.

Hastings.—The Town Council have accepted the following tenders for the boilers and machinery at the proposed electric light station; Messrs. Babcock and Wilcox, Limited, two boilers and superheaters, £854; Messrs. Crompton and Co., three steam alternators, £2,231.

Paris.—The contract for the supply of 10,000 telegraphic cross-pieces to the Post and Telegraph Department on November 26 has been awarded to Bouchacourt et Cie., Paris, at 28,450fr. The other contracts for brackets, etc., were divided between a number of French firms. Lot 11 (U brackets) was not awarded. The copper wire and solder contracts go to Bestrandias, of Paris.

Dublin.—The following tenders were received by the Dublin Bread Company, Limited, for the supply of a motor van:—

Cutting Bros., Derby	£373
Arnold's Motor Carriage Company, East Peckham	350
Gerhardt and Olhme, Leipzig-Lindenau	250
New and Mayne, Westminster	250
Watford Engineering Works, Watford	275

West Ham.—Mr. J. J. Steinitz the borough electrical engineer, informs us that 97 tenders were sent in as the result of advertisements appearing in the technical papers for new plant. The Council have adopted the tenders of the following firms:

	£	s.	d.
S. Z. de Ferranti, Limited, steam alternators and exciters	£9,600	0	0
W. H. Allen, Son, and Co., surface condenser and pumps	650	0	0
S. Z. de Ferranti, station switchboard	633	0	0
British Insulated Wire Company, high and low tension mains, etc.	8,094	11	0
Brush Company, Limited, transformer sub stations and transformers	1,453	10	0
General Electric Company, Limited, instruments	260	0	0
Drake and Gorham, arc lamp-posts and transformers	2,530	0	0
Taylor and Hubbard, 10-ton crane	246	0	0

BUSINESS NOTES.

Sonning.—An electric light column has been erected on the bridge.

Western and Brazilian Telegraph Company.—For the past week the receipts were £2,804.

Great Northern Telegraph Company.—For the month of November the receipts were £24,000.

Walsall.—The electric lighting of the shops in Digbeth and High street appears to be giving great satisfaction.

Stourport.—A fund has been started for the purpose of providing an electric organ at the parish church.

South Shields.—Mr. Jeckell, the borough electrical engineer, is getting out estimates for lighting the parish church clock with electricity.

An Armoured Motorcar.—It is stated that the War Office has under consideration a type of motorcar, armoured and armed, for purposes of war.

Blackburn.—The question of lighting the sewage works at Samlesbury by electricity has been referred to the sub-committee to consider and report upon.

Levenshulme.—The seal of the District Council was affixed at the last meeting to a memorial to the Board of Trade for an electricity provisional order.

Malta.—Valetta and its suburbs, together with the harbour, were lighted last week by electricity for the first time. The inauguration was very successful.

Acetylene.—New acetylene works are to be erected at Vernayaz, Valais, Switzerland, on a capital of £50,000. The turbines, driven by water, are to be of 100 h.p.

Middlesbrough.—The minute agreeing to ask the Imperial Tramways Company to submit proposals of extensions to the Streets Committee has been passed.

Lisburn.—The Streets Committee of the Commissioners have been empowered to engage an electrical engineer to report on the prospects of electric lighting in the town.

Boston.—The Harbour Commissioners have unanimously resolved to light the dock by electricity, at a cost of £1,294. 4s. A scheme for lighting the town was not entertained.

Dover.—The report of the town clerk and surveyor strongly recommending the adoption of the overhead system for the tramway has been referred to a sub-committee.

Dingwall.—Electric light will probably be introduced here shortly. The Town Council have asked for certain proposals on behalf of a company to be submitted in writing.

Blackpool.—A start has been made with the construction of a double line of tramways along Station-road, South Shore, connecting the Lytham-road and promenade sections.

Watford.—The Urban Council will hold a special meeting on the 31st inst. for the purpose of passing the formal resolution applying for a provisional order for electric lighting.

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Catalogues.—We have received catalogues from the Electrical Company, Limited, Messrs. Samuel Withers and Co., and Messrs. Mavor and Coulson, which we shall notice in next week's issue.

Lambeth (London).—The *Gazette* of December 4 contains the notice of the application of the Lambeth Vestry to transfer their provisional order to the South London Electric Supply Corporation, Limited.

Standard Gauges.—Messrs. Lehmann Bros., of Torriano-avenue, N.W., inform us that they are now manufacturing the half-nut gauges recommended by the British Association in their last report.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended December 6 amounted to £1,069, as compared with £1,042 in the corresponding week of the previous year, being an increase of £27.

Commercial Cable Company.—A special meeting of the shareholders of the Company will be held at the Company's offices in the Postal Telegraph-building, 253, Broadway, New York, U.S.A., on December 22, 1896, at 11 a.m.

Hastings.—Judging by the number of applications granted by the Town Council for permission to fix projecting arc lamps outside premises, there is a growing, strong demand for electric light in the town at the present moment.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ended December 4 were £1,892. 5s. 10d., compared with £1 841 1s. 5d. for the corresponding period of last year, being an increase of £51. 4s. 5d.

Edinburgh.—At the Town Council meeting it was remitted to the Lord Provost's Committee to consider the advisability of giving consideration to the more recent mechanical motors in view of the tramway extension to Portobello, and report.

Correction.—In an advertisement last week for an assistant engineer at Derby, the salary offered was given as three guineas a week, when two guineas was the sum intended. The advertisement is reprinted in its correct form in this week's issue.

Bucklow.—A copy of the Manchester Carriage and Tramway Company's scheme deposited in Parliament, with the plans, were before the Council at their last meeting, and it was decided to call a special meeting a month from that date to discuss the matter.

Guildford.—A letter was read at the Town Council meeting from the Guildford Electricity Supply Company, Limited, stating that the company was now prepared to supply electric current for street-lighting, and, if the Council desired, they would send estimates.

Eastern Extension Telegraph Company.—The directors of the Eastern Extension, Australasia, and China Telegraph Company, Limited, have declared an interim dividend for the quarter ended September 30 of 2s. 6d. per share free of income tax, payable on 15th prox.

Postal Telegraph Cable Company of New York.—A quarterly dividend of 1 per cent. will be paid on January 15 out of the net earnings of all stockholders of record on December 31. The transfer books will be closed on 31st inst., and reopened on the morning of January 7.

Caswell, Limited.—This Company has been registered, with a capital of £50,000 in £1 shares, to carry on the business of manufacturers and dealers in cycles, launches, motors, and carriages of all kinds, as electricians, etc., and as producers and suppliers of motive power, light, and heat.

City and South London Railway.—The returns for the week ended December 6 were £1,052, compared with £977 for the corresponding period of last year, being an increase of £75. The total receipts for the half-year 1896 were £21,947, compared with £20,527 last year, being an increase of £1,420.

Downham.—Mr. A. B. Bird gave notice at the Urban District Council meeting that he would apply to the next meeting to carry an electric wire alongside his present telephone wire, and on the same posts, from his flour mills to his private residence, for the purpose of lighting the latter by electricity.

Westralia Motor Carrying Company, Limited.—This Company has been registered, with a capital of £7 in £1 shares, to carry on the business of carriers, transport agents, coach and carriage builders, cycle, motor, carriage, and autocar manufacturers, dealers and repairers, engineers, machinists, etc.

Burnley.—At the Town Council meeting, Councillor Parsons submitted for adoption the minutes of the Gas and Electric Lighting Committee. Councillor Dickinson called attention to the dark state of the road near the Cross Keys Hotel. Councillor Parsons promised to bring the matter before the proper authorities.

Cheltenham.—The Town Council have decided that the gauge of the proposed light railway shall be 3ft. 6in. instead of 4ft. 8½in., and they have also decided to oppose the railway altogether unless Section 21 is so modified that no other power except electricity be used without the sanction of at least two-thirds of the Council.

Bedminster.—Resolutions were passed at a meeting of ratepayers in favour of the extension of the tramways by electrical power, and of the provision of the power by the Corporation, and also that the tramways company, if in five years a better means of traction than the overhead system were discovered, should be compelled to adopt it.

The Electrophone.—The principal London theatres were placed in connection with the Railway Hotel, Bromley, last week, and at the invitation of the National Telephone Company a large number of leading local tradesmen and others attended. The Telephone Company have opened new offices at 13, East-street, Bromley. The Bromley Urban Council Offices have been connected in a similar manner.

Govan.—A deputation from the Parish Council has been received by the Tramway Committee of the Town Council. The object of the deputation was to press on the committee the advisability of extending the present car service to Linthouse terminus—a distance of 600 yards beyond where the cars presently stop. The committee promised to give the request their careful attention.

Altrincham.—The Clerk reported at the Urban District Council meeting that he had received within the time specified a notice and a copy of the plans from the Manchester Carriage and Tramway Company of their intention to apply to the Board of Trade for a provisional order to construct a line of tramways through the district. It was agreed to refer the matter to the Highways Committee.

Bedford.—The electrical engineer to the borough electric lighting works reported at the recent meeting of the Town Council respecting the presence of coal-gas in the electrical street boxes. The gas company have previously been informed of the serious state of things, but it has not been remedied. Proceedings were directed to be taken against the gas company if the matter was not promptly seen to.

Another Electrical Exhibition.—It is stated that arrangements on a very large scale are being made in Como, Italy, for an electrical exhibition and congress, to be held in 1899, to commemorate the centenary of the invention of the voltaic pile. It was in 1799 that Alessandro Volta, the inventor, while professor of natural philosphy at the University of Paris, made the discoveries that have immortalised his name.

The Dardanelles Forts.—An Austrian military paper states that two electric search-lights have been sent especially from St. Petersburg for the new fort of the Dardanelles known as the Sultan Abdul Hamid, and with them went the artificers and engineers to place them in position. A Russian professor has offered his gratuitous services for the working of the search-lights, and these have been accepted.

Bury.—The minutes of the Electric Lighting Committee, which were not discussed at the Town Council meeting, stated that Councillor Ashworth had been appointed chairman and Councillor Ward deputy-chairman of the committee. The Borough Engineer reported that the application of the Technical Instruction Committee to connect the school with the Corporation electricity mains was neither feasible nor desirable.

Ambleside.—A letter was read at the District Council meeting from the Board of Trade relative to electric light, and on the suggestion of the clerk the memorial asking for power to apply the light in the Council's district was signed. The Lighting Committee's report was read, which showed that several lamps, posts, and brackets were necessary and that other minor improvements were wanted. The report was adopted.

Paris.—It appears that all the deliberations of the Municipal Council concerning the Metropolitan Railway are likely to be fruitless. In order, however, to augment the means of transport in view of the exhibition, the Council will, in the long run, probably accept the proposals of the Eastern and Western Railways to prolong their lines towards the centre of the city. The extension of the electric tramways is also proposed.

Aberdeen.—The Watching and Lighting Committee have appointed a sub-committee to meet the Harbour Commissioners with the view of endeavouring to arrive at some satisfactory arrangement in reference to the proposal to light the docks by electricity from the Corporation mains. The Town Council are still experimenting with electric street lighting. The electric light has been installed at Kemnay granite quaries by Mr. John Fyfe.

Dewsbury.—For six weeks ended November 21 the electric energy discharged was 17,649 units, against 11,187 last year. A letter was read at the Town Council meeting from the secretary to the Electric Lighting Extension Syndicate, asking whether the Corporation would enter into an agreement for the supply of electric energy to the syndicate, such energy to be distributed by them through penny-in-the-slot meters. The application was not entertained.

Harwood.—A letter was read at the District Council meeting from the captain of the fire brigade, urging the necessity for having electric fire bells fixed in the firemen's houses in order to save time when a fire occurred. He pointed out that at the recent fire at Rishton the members of the brigade had to be knocked up, causing considerable delay. The cost, it was stated, would be about £30. The matter was referred to the Fire Brigade Committee for consideration.

Copenhagen.—There is a project on foot for an electric aerial railway from the heart of the city to the woods called Charlottenlund, lying to the north along the Sound. The cars will run at an altitude of about 15ft. to 16ft. from the ground, and at a maximum speed of 31 miles an hour. It is proposed to have 10 cars, each accommodating 40 passengers, and running every four or five minutes. The distance which it is proposed to traverse is about five miles.

Darfield.—The Chairman explained at the Urban District Council meeting that the Houghton Main Colliery Company had not sufficient power to supply Darfield with the electric light. The Rev. B. T. Barnes said it would be too costly a thing to put their own plant down. The Chairman said it would be better not to rush forward in this matter, as he understood from an expert that the electric light was as yet in its infancy. The matter will receive further consideration.

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Hull.—A long discussion took place at the last meeting of the Town Council on the proposal to adopt a scheme emanating from the Electric Lighting Committee to extend the present installation in the town by the adoption of the high-pressure tension, at a cost of £42,000. Objection was taken on the ground that, as the low-tension principle was a proved success, it ought to be continued. Ultimately it was decided by 26 to 24 to send the minutes back for further consideration.

Morley.—The Corporation have given formal statutory notice of their intention to apply to the Board of Trade, under the Electric Lighting Acts, 1882 and 1888, to authorise the supply of electricity for public and private purposes within the borough of Morley. The names of the streets in which it is proposed that electric lines shall be laid down within a specified time are Queen-street, Chapel-hill, and Church-street. The area is but a circumscribed one. It will, however, suffice for the present.

Swansea.—A statutory meeting of the ratepayers has been held to consider the proposal to promote a Bill in Parliament for the acquisition of the Swansea tramways and for other purposes. There was a strong rowdy element in the room, and considerable disturbance was made by employés at the gasworks The resolution consenting to the Bill was lost, and a poll of the town will now be taken. The question has been the subject of hot debates at various ratepayers' and other meetings.

Wrexham.—At the Town Council meeting it was reported that the Rural District Council had resolved to object to the inclusion in the provisional order to be made by the Town Council for the purpose of providing electric lighting of the portions of Stansty and Broughton lying within the parliamentary borough of Wrexham and the townships of Bersham, Erddig, Abenbury, and Acton. It was thereupon resolved that the area proposed to be lighted should be limited to the municipal borough.

Changes of Address.—All communications to the Technical Education Committee of the Kent County Council should be addressed in future to the committee's new offices at 53, Parliament-street, Westminster, S.W. The chairman of the committee is Mr. Geo. M. Arnold, J.P., D.L., Milton Hall, Gravesend.—Mr. S. Bousfield Tatham, electrical engineer, informs us that in consequence of the greatly increased business he has removed to larger offices and showrooms at 26, Thurloe-place, South Kensington.

Prestbury.—A letter was read at the Parish Council meeting from the clerk to the County Council asking the Council's opinion with regard to the proposed light railway for Cheltenham: (1) Were they in favour of a light railway to be worked electrically and to run by the side of the main road? (2) should this railway be suitable for carrying heavy goods, as coal or corn? and (3) should the gauge be the same as an ordinary railway? The matter was placed on the agenda for next meeting, along with other suggestions.

Railways and Motor Competition.—The Liverpool and Lancashire Transport Company having instructed their surveyors to report as to using Liverpool and Manchester highways for motor traffic from the ship's side to the warehouses in Manchester, the surveyors have just completed their task, and report the suitability of these roads for motor traffic. It is calculated that merchandise can be carried between the two cities at one-third the present railway rates. It is understood that a new company will be formed at an early date.

Electric Welding.—At the conversazione given by the Institute of Marine Engineers at Stratford on December 4 the Electric Welding Company, Limited, of 21, Hindon-street, Pimlico, S.W., showed a most interesting and varied assortment of samples of welding work executed by the Thomson patent electric welding apparatus. In addition to a new type of automatic welder for iron, copper, etc., they exhibited an entirely novel departure in a complete set of electrically-welded fittings for cycle work, which comprised head lugs, main bracket lugs, rear forks, and pedals.

Waterloo.—At the Parish Council meeting the Clerk said he wrote to the electric tramway company asking them what progress they were making with their scheme, and he had received the following reply: "Dear Sir,—I am instructed to state that my clients are busy negotiating a contract with the Corporation of Ashton-under-Lyne for the supply of electricity. They are also getting on as fast as possible with the other many preliminary steps and contracts before they start upon the ground. The matter is not being delayed in any way.—Yours, faithfully, L. Marl."

Personal.—According to unanimous recommendations of committees of the St. Pancras Vestry the salary of Mr. David Arthur Smith, assistant clerk in the electricity and public lighting department is to be increased from £100 to £120 per annum; and Messrs. Henry Ridley Burnett and Percy Nicholas Hooper, electricians at the King's-road station, are to be promoted to the positions of assistant engineers at the station, and their salaries to be increased from £110 to £140 per annum each.—The salary of Mr. Thornhill, assistant manager at the Taunton borough electric light works, has been increased from £75 to £100 per annum.

New Copper Company.—The Mountain Copper Company, Limited, has been formed, with a capital of £1,250,000, for the purpose of acquiring and working on an extended scale the copper mines belonging to the Mountain Mines, Limited, situated at Iron Mountain, Shasta County, in the State of California, the smelting works connected therewith, and other extensive property, as well as the entire interest in the railway to the mines, and also the refining works in the neighbourhood of New York, owned by the New Jersey Metal Refining Works, Limited. The capital is divided into 250,000 shares of £5 each, of which 83,326 fully-paid are reserved for the vendors in part payment of the purchase-money, and the remaining 166,674 shares are now being offered for subscription.

Tunbridge Wells.—The introduction of electricity for the purpose of lighting the streets of the town is converting most of its old opponents by reason of the great contrast between the streets lighted by electricity and those lighted by gas. These latter streets were always considered to be well enough lighted, but now the contrast is so great that they appear to be almost in total darkness. The consequence is that the Town Council has been inundated with complaints, and the question of improving the lighting of side streets has been referred for the deliberation of the Lighting Committee. The price of current for motor purposes has also been referred back to the committee. The committee had already recommended that current should be supplied to the omnibus company at 3d. per unit.

Electric Locomotives.—According to the *Railway Gazette*, the three electric locomotives of the Baltimore and Ohio Railroad Tunnel Line at Baltimore, O., will soon be used to handle the passenger trains as well as the freight trains. The overhead conductors are being extended three-quarters of a mile northward—to the new Mount Royal Station—and 1,500ft. southward, to obviate the necessity of using steam "pusher" engines on the tunnel approaches. The electric engines are giving good satisfaction, and the maximum load hauled so far has been a train of 41 loaded freight cars with two locomotives not working. The electric power plant is now being used not only to furnish the power for the tunnel locomotives, but to run 180 street cars of the Baltimore Traction Company, and also to furnish a large amount of light.

Brighton.—Great sympathy is felt for Mr. Volk in the loss he has suffered through the gales of last week. Not only was his electric tramway along the Madeira-road very seriously damaged, almost half of it being destroyed, but the new Brighton and Rottingdean electric seashore railway which was opened a week previously was also affected. The car was smashed and a portion of the line injured, while the waiting-room at the Brighton end was almost razed to the ground. This loss, of course, will be borne by the company, but the other falls on Mr. Volk alone. Mr. Volk has successfully overcome many serious obstacles at Brighton, and there is no doubt he will "still come up smiling," although perhaps this is the hardest blow of all. A fund has been started in the town and liberally responded to, as a mark of the sympathy felt by his fellow-townsmen.

City and South London Railway.—In the course of an interview with a representative of the *Financial News*, Mr. Thomas C. Jenkin, the general manager of this railway, said they were going to connect at Lombard-street with the Central London and the City and Waterloo by means of a subway to the Mansion House Station, and at Moorgate-street they would connect with the Great Northern and City. On this railroad the tunnels will be very large, and will accommodate ordinary railway carriages. At a point about Finsbury Park an ordinary train will enter the tunnel; here the steam-engine will uncouple and an electric locomotive take its place. The electric locomotive will bring the train right on underground to a Moorgate-street station. With that station, when it is constructed, the City and South London Company will connect. All these electric lines will dovetail more or less.

Manchester.—A special meeting of the City Council has been held for the purpose of determining on an application to the Board of Trade for authority to extend the tramway system of the city. The extension includes the doubling of the line in part of Cross-street and part of Chorlton-road, the making of new lines in Ashton New-road, Moss-lane East, Denmark-road, Greenheys-lane, and certain minor changes. Mr. Alderman Milling proposed that such application be made. The Highways Committee, he stated, had found these extensions to be highly desirable. Mr. Tunstall seconded the motion. Mr. Sutton suggested an extension of the tramways by Ashton New-road to Audenshaw, but was reminded by Mr. Alderman Milling that this would be a work for the tramways company and not for the Corporation, Audenshaw being outside the city boundary. The resolution was passed unanimously.

An Electrical Company in Liquidation.—Meetings of the creditors and shareholders of Inrig and Chester, Limited, electrical engineers, White Post-lane, Victoria Park, have been held at Carey-street. Mr. Cully, assistant receiver, said the history of the company was very short, and, so far as the creditors were concerned, very disastrous. It was registered in February last to acquire the business of the Globe Electrical Company, in order to meet the wishes of Mr. Chester, who was asked to become a partner with Mr. Inrig in the business. The nominal capital was £2,000, but the only shares issued were £500 to Mr. Inrig as vendor and about £600 to Mr. Chester or his relatives. As time went on money was required, and was raised by means of loans secured by a charge over the whole of the assets. The unsecured debts were estimated at £1,583, and the assets at £100. The case was left with the official receiver, to be wound up in the usual manner.

Colchester.—The Electric Light Works Committee reported at the Town Council meeting that at a meeting of the committee on November 20, a letter was read from the engineer to the Great Eastern Railway Company with reference to the lighting of the North Station, and the borough surveyor was instructed to confer thereon with the engineer or with the district engineer, Mr. Jones. A letter dated November 14 was read from Messrs. Elwes and Turner, solicitors for Mr. A. T. Osborne, enquiring whether the contract for sale of the site for an electric lighting station is to

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be carried out, and the committee desired the town clerk to communicate with the Local Government Board. The military authorities wrote, under date November 14, stating that the new military hospital would be occupied on Monday, November 16, from which date the electric light would be required; and the borough surveyor reported that all needful arrangements had been made. The report was adopted.

Birmingham.—The electric lighting of the annual exhibition at Bingley Hall was carried out by the Walsall Electrical Company, Limited, whose engine and dynamo were working in view of the public.—Mr. William Cope, of Bristol-road, has submitted to Dr. Hopkinson, the special tramway adviser of the Corporation, and also to the members of the Public Works Committee, the specification of a patent he has taken out for improvements in connection with conduits for electric tramways. The principal features of the patent are a chamber of special form—somewhat bottle-shaped—wherein the electric conductor is to be laid; and, secondly, an internal car, forming a covering to the conductor, and protecting it from any dirt or wet that may fall through the slot rail. The form of conductor is also patented. It is claimed for it that it can be more cheaply constructed than other underground systems, that it secures perfect insulation, and has the advantage of being with easy reach of the surface.

Kirkby.—At the District Council meeting the question of lighting the parish with electricity was fully discussed, and Mr. Leivers contended that the matter was floored, he having asked for an estimate and been told that it would cost a matter of £12,000. Mr. Shacklock said this was out of reason, and the undertaking would cost no such amount. He believed that if the parish laid down a plant it would be an ultimate saving to the ratepayers. The Act would not allow them to take over the plant of the Sutton Gas Company. He was most anxious that the benefit of the ratepayers at large should be considered, and he believed that if a plant were laid down the whole of the ratepayers would benefit. Mr. Gelsthorpe moved that Mr. Furse, of Nottingham, be asked to prepare an estimate, after ascertaining his fee for the estimate. Mr. Hayes thought the matter altogether impracticable, and any money spent in the matter would be a waste to the parish. Mr. Gelsthorpe was of the same opinion, but others on the Council had a different view.

Londonderry.—Councillor Thompson has been elected chairman of the Lighting Committee. Councillor Hastings, in supporting the motion, said he felt convinced that Councillor Thompson would, as chairman, help to have developed the electric lighting of the city. They wanted about £30,000, whether Councillor Thompson liked it or not, to develop and encourage private lighting by electricity and to complete the public lighting of the streets electrically. At present they were labouring under a discount. Their generating power was good enough, but the electric light—that is, 170 lamps—cost more money than the gas of old did. He would suggest to Councillor Thompson to formulate a scheme to raise £30,000 to carry out to a satisfactory completion the public lighting of the city, and to provide, in addition, private lighting by electricity. There were some streets as yet insufficiently lighted. He was of opinion that 30 more electric lamps were wanted to complete the public lighting and have the necessity for the use of gas lamps obviated.

Shoreditch.—The Vestry have approved of a further report of the Works Committee stating that they had considered a report and plan prepared by the surveyor with reference to the ventilation of sewers, and they had decided to make an experimental connection at Bowling Green-walk, with the intake of the forced-draught fans of the destructors on the electric lighting station, at a cost of about £10, and that observations of the influence on the sewers be then taken. They had authorised the surveyor to obtain an anemometer for this purpose. The Electric Lighting Extension Syndicate, Limited, forwarded a draft of the terms of agreement which they proposed to enter into with the Vestry. They wished to be placed on the same level as any other large consumer of electric energy in the district at a reduction on the Vestry's usual rate. The syndicate further pointed out that the introduction of their penny-in-the-slot meters and free wiring would no doubt induce many to use electricity, and greatly benefit the Vestry's undertaking. The letter was referred to the Electric Lighting Committee.

Electric Lighting of Trains.—The *Newcastle Daily Chronicle* says: "While the members of the Tynemouth Recreation Association are about the work of asking for increased facilities from the railway company, they might point out the need there is for lighting up the carriages during the long tunnel passage under the town of North Shields. In these days of electrical engineering skill there cannot be any difficulty about switching on the electric light when a long tunnel is being entered. Indeed, it is already done on many of the South Country railways, and it is very needful that it should be done on the Tynemouth line for the sake of ladies and children travelling to the seaside. Perhaps Mr. Engel will undertake to show the directors and engineers of the railway company how easily the thing could be accomplished when he opens his electrical exhibition at Pandon Dene in February next. Newcastle has lagged woefully behind in the matter of street locomotion, but the private enterprise now manifested in the way of electric lighting on all hands serve to show Tyneside does not mean to be last in the race after the light and energy of the near future."

Motorcar in the County Court.—A case affecting the traffic influences of horseless vehicles has engaged the attention of his Honour Judge Shand in the Liverpool County Court, and public interest was shown by the crowded attendance. Mr. J. M. Sutherland, a hay and straw dealer, sued the North of England Horseless Carriage Company for £20. 10s., damage to a pony and trap. A motorcar belonging to the defendants was stationary in London-road on October 3, and just as the engine was set in motion plaintiff's pony, which was being driven past, took fright and came into collision with a bread-van, causing injury to both pony and trap. One of the witnesses for the plaintiff declared that the motor made a noise something like a steam thrashing machine, and another that it was like a railway only considerably reduced. For the other side it was declared that the accident was caused through the carelessness of the pony's driver, as the animal did not take fright until it came into collision with the bread-van. The motor made only a "coughing" sound, ejecting vapour from underneath. In reply to the Judge, Mr. Collingwood Hope (for the plaintiff), said that the car was being run as a locomotive, it being before the Act of Parliament was amended. The jury gave the plaintiff a verdict for £12s. 10s.

Cardiff.—Mr. Atkinson, who is acting for the syndicate which promotes the electric tramway from Cardiff to Penarth, has published a small pamphlet, accompanied by a printed sheet of views, designed to overcome the objection of unsightliness which is always raised against the adoption of the overhead system. Views of electric tramways at Milan, Lubeck, Baden, Havre, and Bristol show that even in surroundings where appearance is of great importance—such as the vicinity of fine public buildings—the overhead wires, with their needful supports, are not destructive of æsthetic effect. The pamphlet deals also with more practical considerations, and demonstrates conclusively that to work by electricity is the best method. Under the heading of "The Logic of Facts," it shows how very rapid has been the growth of electric traction during recent years. At a meeting of the Parliamentary and Tramways Committee the following resolution was unanimously passed: "That inasmuch as the Corporation feel that they should keep in their own hands all their roads within the municipality available for tramways or other purposes, the Corporation cannot consent to the application of the Penarth Tramways Syndicate, Limited, for a provisional order to construct tramway within the borough."

Crystal Palace.—The National Cycle Show has been on at the Palace this week. It covers all the ground floor, and has flowed up into the galleries. The shepherd knows his sheep, and presumably the cyclist knows his cycle, but barring variations in the brakes—when there are brakes—it is difficult for the ordinary man to distinguish the differences marking the goods of the 320 exhibitors. The engineer has never loved the pitch chain, though for some kind of work he would be puzzled to do without it, and it is not surprising, therefore, to notice that there is a continuance of the attempts to get rid of it from the safety. The most hopeful of these appears to be the use of a horizontal shaft and bevel gear, or its equivalent. This is practically indistinguishable from the frame, and at a short distance the machine looks absolutely gearless. There is a great gain in the appearance, but the writer doubts if the arrangement can be built quite as light as the uncased chain, unless strength is sacrificed. One firm by way of showing that it did its own electroplating exhibited two dynamos on its stand. The build of the armatures of these was noticed much more frequently than might have been expected. Hence it may be inferred that there are a considerable proportion of electricians interested in cycles, and this note has come to be written. The show closes on Saturday.

Rotherhithe.—At the Vestry meeting the General Purposes Committee reported that they had considered a letter from Mr. S. Morse, on behalf of the County of London and Brush Provincial Electric Lighting Company, Limited, asking for the formal consent of the Vestry to the application of the company for a provisional order in respect to Rotherhithe. The compulsory streets scheduled were Union-road, Albion-street, Rotherhithe-street, and Lower-road. The committee, having been given power to act, had declined to consent to the application. The Clerk read a letter from the secretary of the company asking the Vestry to reconsider the matter. The company were prepared to enter into an agreement to supply current for street-lighting purposes at 3½d. per unit, and to give the Vestry an opportunity of purchasing the undertaking from the company at the expiration of a time to be specified in the agreement. Mr. Stuart moved that the Vestry approve of the action of the committee in declining to consent to the application. At the present time one electric lighting company had a provisional order entitling them to supply Rotherhithe, and were ready to go on with the scheme if they could secure sufficient customers. He did not think they should allow another company to come in. Mr. Mortimer seconded the motion, which was carried.

Hampstead.—The Lighting Committee reported at the Vestry meeting that they had received a report from the engineer on the growth of the electric lighting undertaking, and the necessity of providing further plant at the central station to meet the demand for current in the winter of 1897, and they were of opinion that the suggestions of the engineer should be carried out, and therefore they recommended that the following additional plant be provided at an estimated cost of £4,500—viz., one 300-kilowatt alternator, with switch-panel, connections, and foundations; one exciter, with switch-panel, connections, and foundations; the second feed-water heater; and one overhead traveller for the second bay in the new engine room. They also recommended that the two new boilers at the electric station be insured against explosion for the sum of £4,000 each in the Boiler Insurance and Steam Power Company, Limited, at a total annual premium of £9. They recommended that low-tension mains for the supply of current to private consumers be laid as follows: Kidderpore-avenue and Platt's-lane (portions), at an estimated cost of £81½;

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and Manstone-road, Shoot-up-hill, £57. The report was adopted. Mr. Reed, chairman of the Lighting Committee, replying to Mr. Farmer, said that the Willesden District Council had sent a letter on the subject of lighting the High-road, Kilburn, by electricity, which would be considered by the sub-committee at their meeting on Monday.

Canterbury.—At the Town Council meeting the Lighting Committee of November 26 reported as follows: "Mr. Alderman Mason was elected charman of the committee for the ensuing year. Mr. R. Hammond attended the meeting. The committee having visited the site adjoining St. John's Hospital and at the rear thereof recommend that the same be acquired, providing satisfactory terms be arranged with the trustees of the charity, and subject to a favourable report being received from the engineer and the surveyor as to the foundations, and that the original scheme, which includes a dust destructor in conjunction with the electric light, be proceeded with. The electrical engineer submitted final plans and estimates, etc., of the electric lighting works and dust destructor. The committee recommend that the same be adopted, and that the engineer be authorised to advertise for tenders for the works and issue the specifications—the tenders to be returnable to the town clerk." Alderman Mason said there were certain reasons why it was desirable that this matter should be discussed in committee. He would therefore move that the report be considered in committee of the whole house at the close of that meeting. The proposal was agreed to. In accordance with this arrangement the matter was discussed in committee. Subsequently the meeting resumed sitting as a town council. The paragraph in regard to the St. John's Hospital site was referred back, and that in regard to the issue of tenders is to stand over for the present. Meanwhile other sites will be inspected.

Grimsby.—The Highways and Public Works Committee at their last meeting considered the proposed application of the Grimsby Street Tramways Company for additional power, especially with reference to the application of electric power. The Chairman remarked that he thought there should be a sub-committee to consider the details of these matters and report to the committee. The Deputy Town Clerk, in reply to questions from several of the committee, explained that the tramway company were applying to the Board of Trade for powers to run trams by electricity in Grimsby, and the Corporation should be in a position to say they had certain powers over them. The Corporation would probably wish to impose restrictions or conditions as to the form of supports for the upright power which was to be applied for working the electric trams; and it might be a question whether they should not ask the company to complete the circuit of the traffic—to ask for powers to unite the two ends of the tramway by means of Welholme-road. And there were many other matters indirectly arising in connection with these applications which needed consideration. Mr. Alward seconded the chairman's proposal for a sub-committee, remarking that he hoped they would not allow the overhead system to be adopted, as it was very objectionable, and he did not know whether or not it was dangerous. They ought all to facilitate the application being granted, but some conditions must certainly require to be imposed. Eventually the sub-committee was appointed to consist of the following: Alderman Dobson, Messrs. Alward, Barrett, Hill, Melhuish, Watkinson, Nutt, and Wintringham.

Portsmouth.—A Local Government Board enquiry has been held into an application by the Corporation for power to borrow £16,020 for electric lighting extension and additional machinery, and the sum required was divided into two items, £6 015 being asked for extension works and £10,005 for new machinery. The machinery section of the account was dealt with by Mr. Manville, who explained that £10,005 was required for an engine and other plant. The demand for the electric light, he stated, had increased beyond the committee's expectation; so much so, indeed, that the spare engine had to be used as well as the other two, and on Mondays and Fridays the plant was overloaded. At present it was impossible to take on more customers. The Inspector inquired if the business was in a satisfactory state and was informed that the profits of the undertaking were 7½ per cent. gross and 2½ per cent. net. Councillor Murtough, speaking as a member of the committee, said it was very gratifying to the whole of that body that the electric light undertaking had proved so successful. Everything was done to make as much as possible out of the present plant, and it was unfortunate that the new engine would take so long to build. Tradesmen were anxious to get the current into their places as soon as possible. Another engine would shortly be required. Mr. H. Johnson asked whether it was not a fact that some people were taking to gas for the winter months, the electric light being too cold. Alderman Ellis replied that he only knew one instance in which a gentleman had voluntarily given up electric light and gone back to gas. After the enquiry the inspector paid a visit to the electric works.

Bristol.—Under the auspices of the North St. Phillip's Labour Electoral Association, a meeting has been held to consider the tramway extension scheme, and a resolution urging the members of the Town Council not to sanction the further extension of electric traction on the tramways unless the supply of electric power be taken from the Corporation was largely out-voted. A meeting, convened by the Bedminster West Ward Ratepayers' Association, has been held for the purpose of being addressed by Mr. George Pearson on the subject of the tramways extension scheme and the supply of the electric power. Three questions were put to the meeting: whether they favoured the extension of the tramways by electrical power; whether they favoured the provision of the power by the Corporation; and whether the tramways company, if in five years a better means of traction than the overhead system were discovered, should be compelled to adopt it? The unanimous answer to each question was in the affirmative. At a meeting of the Stoke's-croft and North-street Ratepayers' Association the following resolution was unanimously adopted: "That before sanctioning any application for tramways extension it should be made a condition that the supply of electric power for use on any lines of trams where electric traction is not now employed should be obtained from the Corporation." We have received a copy of the report prepared by Mr. H. P. Parshall, consulting electrical engineer to the tramways company, which also contains opinions by Prof. Hopkinson and Lord Kelvin agreeing with his recommendations that the company should be allowed to generate their own supply. In spite of this, however, the Town Council have decided against the company.

Rathmines.—A discussion took place at the meeting of the Commissioners in reference to the Tramway Bill about to be promoted by the Commissioners Mr. Carey said he wished to have it made clear that they were determined not to be handed over to the tramway company to be dictated to by them, and be placed in their power. They would be losing a great opportunity if they did not go on with their Bill, and they should not have any compromise. The Chairman stated that in certain papers a bogus advertisement had appeared with reference to the supposed reduction of the franchise, abolition of co option, extension of the wards, and other matters not contemplated in the Bill, good, bad, or indifferent. That advertisement, although Mr. Fawcett's name was used in the matter, was utterly misleading to the public, and was published without any authority. Mr. Regan expressed his opinion that the question as between the Commissioners and the tramway company was one for compromise, and he had attended the ratepayers' meeting in the Commercial Buildings with a view of hearing what was to be said against the Bill. The Chairman said they desired no antagonism with the tramway company. Their only object was to maintain the rights of the ratepayers. Mr. Plunkett expressed his strong desire that before another step was taken they should meet the tramway company. If they could not make a proper arrangement, then he would be in favour of going on with the Bill. At the meeting in the Commercial Buildings Mr. William Murphy was present, and made certain propositions to the meeting which were not set forth in the circular issued by that meeting. It was decided to request the tramway company to furnish a copy of the proposals made by Mr. Murphy.

Caversham.—A letter was read at the District Council meeting from the Imperial Tramways Company, Limited, stating that the company proposed to reconstruct and considerably extend their tramways within the borough of Reading, and to make an extension along the Caversham Bridge, Bridge-street, Church street, Gosbrook-road, and South-street. They applied for the sanction of the District Council for so much of their operations as might be within the district of the Council. The gauge of line proposed to be adopted was 3ft. 6in., or such other gauge as the Reading Corporation and the Caversham Urban District Council might agree with the company. The line proposed to be laid within the Council's district was a single line with passing places or sidings at convenient distances. The company proposed to lay their line upon a solid bed of concrete, and to pave between the rails and for 18in. beyond the outer rails with granite or scoriæ setts, laid throughout in cement grouting and upon the solid concrete. It was proposed by the company, subject to the consent of the Corporation of Reading and the Council, to work the traffic by a system of overhead electric traction, such as was now in operation in several cities on the Continent, and also at Bristol and Dublin. The authorities at all places where the electric overhead system was in operation were perfectly satisfied as to its safety and convenience, and it was in no way objectionable to the ordinary traffic of the road. The standards for carrying the overhead wires were ornamental in design, and could be placed in line with the lamp posts at the side of the road, so as to form no obstacle to traffic. It was decided to call at an early date a special meeting of the committee of the whole Council to consider the proposal of the tramways company.

Bradford.—The Corporation electrical showroom in the Swan-arcade was opened by the mayor (Mr. T. Speight), who is also chairman of the Gas and Electricity Committee on December 2. His worship was accompanied by the other members of the Electricity Committee. The room is not sufficiently large to admit practical experiments where motive power of over 2 h.p. is required, but on a small scale almost every example of the application of electricity is given, while full particulars as to the hiring or purchasing of the numerous appliances are supplied by Mr. J. Copperthwaite, of the Electricity Department. The appliances show the application of electricity as an illuminant, for motive power, and for heating. Under the former head every device of lighting is shown by arc lamps, Ediswan's sunlights, and artistic chandeliers suitable for house or office. Motors are on view from ¼ h.p. upwards. This branch of the showroom the committee are desirous of extending, and special arrangements are being made for hiring the motors. There are a large number of air-fans, and amongst the cooking and heating apparatus on view are hot cupboards for hotels, portable radiators for heating offices, sitting-rooms, etc., electric cookers, kettles, frying-pans, curling-iron heaters, coffee-pots, billiard-table irons, pans of every description, flat irons, and foot warmers. Almost all the articles may be hired. The following firms exhibited motors: R. E. Crompton and Co., Limited, Chelmsford, Essex; J. H. Holmes and Co., Newcastle-on-Tyne; Standard Dynamo and Motor Manufacturing Company, Harris-street, Bradford; Rosling and Appleby, Trafalgar-street, Bradford; Phœnix Dynamo Manufacturing Com-

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pany, Hubert-street, Bradford. The Town Council have decided to light up the main entrance to the town hall and the staircase with incandescent electric lamps, and to erect three new arc light standards in the neighbourhood of the town hall.

Trial of Heavy Motorcars in France.—The Automobile Club, under which were organised the race of light motor carriages from Paris to Bordeaux and from Paris to Marseilles and back, has decided to get up for next year a competition between heavy vehicles propelled by automatic traction, and in order that the makers of all kinds of cars, wagons, and similar vehicles should have plenty of time to prepare for the contest, which is open to all the world, the official programme has already been issued. The contest is to be for vehicles transporting passengers and goods on the high roads not in direct communication with railways, and it is to be held over roads in the vicinity of Paris on July 1 and five following days. The vehicles for passengers must be capable of accommodating at least 10, with 30 kilos (66lb.) of luggage per passenger, while the parcel vans and carts must hold at least a ton of goods. The number of exhibits which each maker may send is not limited, but he can only show one of the some type, and before the trials commence the vehicles entered (fee £8 up to June 1 and double up to the 28th) must be photographed and passed in review by the commission of the Automobile Club and obtain a certificate. The trials will begin on July 1, the distance of 187 miles being divided into six stages of varying lengths, according to the number of stoppages in each mile. A committee will be appointed to see how the competing vehicles work, whether they stop readily on the inclines, what they attain up and down hill, and, in a word, to judge how far they are likely to be of practical use. The prizes will be awarded with special reference to these qualifications, and the Automobile Club will prepare an official report of the trials and send it to all the civil engineers, industrial companies, and mayors in France. Entries may be made and full particulars obtained from the secretary of the Automobile Club, Place de l'Opera, Paris.

Large Transformers.—In the transmission of power from Niagara to Buffalo some large transformers have been used. The over-all dimensions of these, together with their weight, will be of interest to our readers. For the Niagara end of the line the General Electric Company have supplied three transformers, together with an air fan for cooling. Each of these transformers is of 1,250 h.p. capacity, and any two of them can be used to transform 2,500 h.p. delivered to them in two-phase currents at 2 200 volts to three-phase currents at either 11,000 or 22 000 volts. In these transformers the coil connections are so arranged that the change in the voltage from 11,000 to 22,000 can be easily effected. The transformers are each 7ft. 10in. high, and measure 5ft. 4in. by 4ft. 8in. at the base. Each weighs about 25,000lb. A 5-h.p. motor is used to drive the air blast through the coils of these transformers, and also through spaces left in the laminations of the iron cores. The arrangement of coils in these transformers is such that very strong insulation will have to be punctured before connection can be made between the different coils, or between the coils and the iron. At the same time the air-spaces are so placed that the air is brought intimately in contact with each coil, and gives an excellent cooling effect. This method of cooling makes necessary the occupation of a good deal of space in insulation and air, which has a tendency to increase the size of each transformer. Still, it is very apparent that it has the very great advantage of making the transformer clean and accessible. and much more convenient to handle than a transformer cooled by other methods. At the Buffalo end of the line four 255-kilowatt or 360-h.p. transformers are used in reducing the current from the line to a voltage suitable for connection to the rotary converters. These step-down transformers are each 6ft. 10in. high and measure 3ft. 11in. by 3ft. at the base. They weigh about 7,000lb. each. From these details, for which we are indebted to our New York namesake the *Electrical Engineer*, it will be seen that with the large size the weight per kilowatt output is about 26¾lb., and per horse-power is 20lb. In the same size the weight per kilowatt is 26¼lb., and per horse-power 19·5lb.

Coseley.—At the District Council meeting the Clerk laid before the meeting the usual notices required to be given by the promoters of the new tramway scheme, and also read a letter from Mr. A. W. Hickman respecting the proposed line from the Fighting Cocks to Bilston. He asked the Council to insist on the rails being laid on the side of the road instead of in the middle. The effect of laying rails in the middle of a road was to give the maximum amount of inconvenience, while if they were laid on the side the expense of keeping the road in repair would be materially reduced. The Chairman said he had acknowledged the receipt of the letter and had told Mr. Hickman that he personally favoured the idea of the rails being laid on the side of the road. Councillor Clayton also advocated the rails being laid on the side of the road. At present the tramlines monopolised the middle of the road, and it was often difficult for vehicles to pass on either side. Councillor Slater said he believed on the Continent the rails were laid on the side of the road. Councillor Wones said he understood that Coseley and Sedgley Councils were to confer on the subject. Councillor Rolinson said before the rails could be placed on the side of the road the Board of Trade would have to give their sanction. He could mention places where it would be extremely awkward for the lines to be on the side of the road, besides being a great inconvenience to shops. The whole question required careful consideration. As soon as Dudley Town Council heard of the proposals of the syndicate they at once decided to apply for a provisional order to put down an electric lighting station in the town, and the syndicate had already promised to take from Wolverhampton and Dudley a portion of their motive power. Seeing that such a large portion of the tramway passed through Coseley and Sedgley he was not disposed to give away powers they already possessed, but to go in for powers they did not possess. He therefore gave notice that at the next meeting of the Council he should propose that application be made for a provisional order for power to put down electric stations for lighting and for motive power. After further discussion it was decided to arrange with Sedgley District Council for a joint meeting on the tramway question.

Appointments Vacant.—The Crown Agents for the Colonies invite applications for the posts of electrical engineer and assistant electrical engineer in connection with the erection and working of an electric light plant which is about to be established in Lagos, on the West Coast of Africa. The electrical engineer will have to go out with the plant and to superintend its erection and starting to work. Salary £50 per month, and his appointment will be for six months, subject to a renewal for a further period of two months. Salary will commence on date of embarkation, and continue until date of his arrival in England on his return at the termination of his engagement. The assistant engineer will also go out with the plant, and act as the engineer's assistant. He will remain in charge of the plant after it has been completed. Salary £300 a year, and the appointment will be for one year, subject to renewal for a further period of two years. Half salary will be paid during voyages out and home. Free passage out and home again on expiration of engagement will be given. Leave of absence: if engagement is extended for a further two years, six months on half salary after every 12 months' residential service, if exigencies of the service permit, with free passage home and out again. Applicants for both posts must have had a thorough mechanical training and electrical training, and be well versed in the erection and running of locomotive boilers, undertype engines, and alternators. Married men are ineligible, and a strict medical examination will be necessary. Applications, stating age and experience, and accompanied by copies of not more than three recent testimonials, with the names and addresses of references of whom enquiry may be made, will be received by the Crown Agents for the Colonies, Downing street, London, S.W., up to 14th inst. They must be enclosed in an envelope marked "Application for Electrical Engineer, Lagos."—Applications are also invited for an engine-driver and fitter to assist in the erection and working of the plant. Salary £250 per annum, and the appointment will be for one year subject to a renewal for a further period of two years. Applications to be in by the 14th inst.—The Electric Committee of the Belfast Corporation have a vacancy for a temporary draughtsman. Applications to be sent to Mr. Victor A. H. McCowen, city electrical engineer, on or before Thursday, December 17, 1896, endorsed "Draughtsman." See advertisement.

Speed Indicator.—The accompanying illustration represents the chronographic cycle and motorcar speed indicator invented by Messrs. S. Smith and Son, 9, Strand, W.C., an instrument which has already given great satisfaction. The small arc of figures on the left hand of the dial between the 35 and 55 seconds of the outside circle contains divisions giving a range from 40in. to 136in. gears; the small pointer (shown between the figures 40 and 45) is brought round to whatever gear the machine may be (in the illustration it is on to 70, each division line counting as two); the pointer once set it is only necessary to count the number of pedallings that are done while the long hand is travelling from zero (that is, the 60th second) until it crosses the large pointer (shown between figures 10 and 15) and the number counted is the speed in miles per hour that is being traversed at the time of observation, say, 10 pedallings—10 miles per hour is the speed. If the number of pedallings in the same period is increased to 15—then 15 miles per hour is being done.

The rim or glass is made to revolve, so that it is possible to adjust the instrument and to record the speed for or by any rider, and on any machine. For the rider's own use it is attached to the handle-bar, for which purpose a special carrier has been designed. The important parts of the watch that are liable to be damaged by damp are made of palladium, which does not rust, and therefore the watch is also non-magnetisable. The price of the instrument is £2. 2s.

Belfast.—At the Town Council meeting the town clerk read the minutes of the Council in committee in regard to the proposal made by the Corporation to the tramway company as to the terms upon which they would permit the introduction of electrical traction—namely, 6 per cent. on the gross receipts. Councillor John M'Cormick, in moving the adoption of the minutes, said when he found an overwhelming majority of the Corporation

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deciding in favour of the overhead system, he considered it was his duty to see that the Corporation should receive the best terms for giving its sanction to the introduction of the electrical overhead system, that a sum of 6 per cent. on the gross receipts should be paid to the Corporation by the tramway company. He thought this was a very reasonable proposal, and he thought the strongest argument in favour of it were the figures supplied by the company itself. They simply adopted the figures of the company for the remainder of the existing terms. Alderman Henderson, in seconding the resolution, did not think it would be at all fair that the Corporation should attempt to fix the distances the trams should run for penny or twopenny fares. They should try to get as large a sum as possible for the ratepayers, and he had no doubt the tramway company would see it was to their advantage to increase the journeys and reduce the fares. The motion was carried by 26 to 5. The Electric Lighting Committee reported that they proposed from time to time, as occasion may require, to take into the works young men qualifying themselves as engineers as improvers, each party on being approved to pay a fee of £50, which shall entitle him to remain in the works for three years, provided he shall conduct himself to the satisfaction of the committee and their engineer, and discharge in a proper manner the duties to be assigned to him, wages at the rate of 5s. per week to be paid him for the first year, 10s. per week for the second year, and 15s. per week for the third year. The committee also recommended that the yard in M'Auley-street be taken as a site for the electric station. The adoption of the report was moved by Councillor Jaffe, and seconded by Councillor Weir. Councillor Woodside said they were about to expend about £100,000 on a new electric station, and he thought a suggestion should be made to the committee that they should confine the preparation of plans for the new building to local architects. Councillor W. M'Cormick wished to know if the plan could not be prepared in the surveyor's department. Councillor Murphy thought the electrical engineer would be quite capable of preparing the necessary plans. The report was adopted.

Yarmouth.—It was reported at the Town Council meeting that the representative of the British Thomson-Houston, Limited, and Mr. Waller, of the firm of Messrs. Kincaid, Waller, and Manville, consulting engineers, had discussed with the Lands Committee the route of the proposed Great Yarmouth tramways, and explained the method to be adopted in the construction and working. The committee recommended the Council to approve the route as shown in the deposited plans, upon the understanding that in the event of tramway No. 9 (Regent street, Regent-road, etc.) being authorised, a clause should be inserted in the provisional order to the effect that previous to the exercise of such powers the promoters shall obtain the express permission of the Corporation. It is further recommended that consent be also subject to the insertion of such other clauses in the provisional order for the protection of the interest of the Corporation and of the public as might hereafter be considered advisable. Mr. F. Burton moved, as an amendment, that the part of the scheme from the Drive down King's-road to the quay be excluded. He was aware it would destroy the continuity of the route, but he protested against trams going round such a narrow corner. He suggested an alternative route by Albert-square or Barrack-road. Mr. A. Youell seconded. Mr. C. H. Wiltshire objected to trams going down Regent-street or Regent-road, owing to the sharp corners from King-street. The Deputy-Mayor (Mr. T. A. Rising) said those thoroughfares were only introduced upon the suggestion of members of the Council, and he pointed out that previous to the exercise of those powers the permission of the Corporation must be obtained. Mr. T. Green condemned the whole scheme, believing it would not pay, and in that event great inconvenience would be caused by the pulling up of the roads in order to lay the lines, and afterwards relaying them. He referred to the failure to carry out a previous scheme, and quoted Ipswich and Colchester as towns where tramways had not been a financial success. Where the traffic was to come from during nine months of the year he did not know. The amendment proposed by Mr. Burton having been defeated, Mr. Wiltshire moved that the whole question of route be referred back to committee, on the ground that it had not received proper consideration, especially if, as had been stated, the permission of the Council, if obtained, was intended to be disposed of subsequently by the company in question. Mr. T. Green seconded. Mr. H. Chamberlain said Regent-street and Regent-road were only inserted in deference to the expressed wish of several members of the Council. The whole question of route was then referred back.

Keswick.—At the Urban District Council meeting the Deputy-Clerk read the following letter from the Keswick Electric Light Company: "I am instructed by the directors of the Keswick Electric Light Company, Limited, to say that they accept the electric lighting provisional order of the Keswick Urban District Council on the terms named in your letter of the 4th inst. In doing so, the directors think that one or two slight modifications in the terms will be readily allowed by the Council. In Clause 3 the words 'or nine pillars and lamps of 16 c.p. each' should be expunged. It would not be satisfactory either to the Council or this company to have single 16-c.p. lamps placed in conspicuous positions. From the former part of Clause 8, ending with the words 'obligation, etc.,' the following words only should be substituted, 'In case the winding-up of the company.' The clauses thus altered will fully meet the needs of the Council. The latter portion of Clause 10, following the words 'Board of Trade,' is understood to be in effect a repetition of Clause 2." The following is a summarised statement of the terms offered by the Council in their letter of the 4th ult.: "(1) The Council propose to transfer to the company their provisional order for electric lighting except Sections 7, 53, 54, 60, and 69 (which do not apply to a company) for the consideration and on the terms following. (2) The company to pay to the Council on the execution of the transfer the whole of the costs incurred by them in obtaining the order and the Act in confirming the same. (3) The company at their own cost to erect and maintain in such places within the district of the Council as the latter shall point out three pillars and lamps of 50 or three of 16 c.p. each, or nine pillars and lamps of 10 c.p. each and free of charge and keep the same lighted during such period each 24 hours as the Council shall prescribe in respect of the gas or other lamps used for lighting their district. (4) The company to execute all compulsory and other works and exercise the powers of the provisional order. (5) The company not to sub-let, assign, or part with the possession of the order or apply to the Board of Trade for leave to do so without the consent of the Council. (6) The transfer to contain all usual and necessary clauses to safeguard the public and ensure due execution of the order. Any case of difference to be settled by the Board of Trade. (7) At any time after the expiration of 42 years from the date of transfer the Council may by six months' notice in writing have the option to purchase the company's undertaking on the terms of paying the value of the undertaking. (8) In case of the bankruptcy, insolvency, or winding-up of the company, or failure of the company to fulfil their obligations, the Council to have power to take possession in the same manner as if the 42 years had expired. (9) The Council to have the privilege of executing all necessary works affecting any streets, bridges, sewers, etc., under their control the company paying all expenses. (10) Any agreement with the company for transfer or purchase, etc., to be subject to the sanction of the Board of Trade, and the costs of the Council in the negotiations for the company's works, including the solicitors' and engineers' charges, etc., to be paid by the company. A resolution was passed authorising the solicitors to the Council to inform the company that the Council consented to the alteration in the terms with regard to lights, and to arrange for the preparation of the necessary deed for the transfer of the provisional order to the company.

Reading.—At the Town Council meeting the Finance and General Purposes Committee reported that at a meeting of the committee on November 13 the town clerk submitted a notice received by him of a proposed application to the Board of Trade for a provisional order authorising the construction of tramways in this borough. The following letter was received from Mr. Francis, secretary to the Reading Electric Supply Company: "With reference to the recent minute of the Town Council respecting the proposed introduction of electric tramways in Reading, I am directed to acquaint you that when the Council have come to a decision in the matter and are prepared to receive applications my Board will be glad to make a communication to the Council." It was decided "that, as soon as the advertisement of the intended application has been published, and the plans and other documents required by the Tramways Act, 1870, and the standing orders of Parliament, to be deposited on or before November 30 shall have been published and deposited, the borough engineer and surveyor do report on the proposed scheme, in order that the committee may consider and recommend to the Council whether the Council, as the local authority for this borough, should give their consent, which is required by the Tramways Act, 1870, to the proposed tramways, or should refuse to consent thereto, and, if so, upon what grounds, and generally as to the steps which the committee may consider best calculated to protect and secure the interests of the borough in the matter." At a meeting on November 27 the town clerk submitted a copy of a newspaper containing a parliamentary notice of an intended application to the Board of Trade by the Reading Tramways Company, Limited, for a provisional order under the Tramways Act, 1870. He also submitted a letter, dated November 11, from Mr. J. Clifton Robinson, C.E., the managing director of the company, giving certain explanations with reference to the proposed new scheme, which was accompanied by certain plans purporting to illustrate the intended lines of tramways and other particulars with reference thereto. The committee considered the matter, and the town clerk gave explanations as to the legal position of the Corporation and the company respectively with respect to the existing tramways and the proposed new tramways respectively under the Tramways Act, 1870, the Reading Tramways provisional order, confirmed by Parliament in the year 1878, and the standing orders of Parliament. It was resolved to recommend to the Council as follows: "That the Council, being the local authority and the road authority under the Tramways Act, 1870, do not consent to the proposed scheme for tramways indicated in the parliamentary notice now submitted to the committee, for the reason, amongst others, that it appears that if such consent were given and the proposed new system of tramways were authorised by provisional order confirmed by Parliament the powers and privileges of the Corporation with respect to the purchase of the existing tramways after August 16, 1897, would be postponed and otherwise prejudicially affected. That the retaining by the town clerk of Messrs. Sharpe and Co., of 9, Bridge-street, Westminster, to act as parliamentary agents for the Corporation in the matter be approved. That the borough engineer and surveyor, when presenting the report ordered by the committee on the 13th inst., do also report as to the various systems of traction, other than animal traction, available for the working of street tramways and their comparative suitability for tramways in the streets of this borough, particularly the streets included in the proposed scheme of the Reading Tramways Company, Limited." The report was adopted.

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PROVISIONAL PATENTS, 1896.

NOVEMBER 30.

27167. **Improvements in electrical batteries.** Charles Edouard O'Keenan, 8, Rue de Princes, Brussels.

27188 **Improvements in or relating to electro-mechanical indicating and recording apparatus.** Charles Edward Vernon and Arthur Ross, 111, Hatton-garden, London.

27195. **Improvements in electrical switches** Jacob Gutmann, 6, Bream's buildings, Chancery lane, London.

27207. **Improvements in the electric ignition of charges in explosive engines.** Edward Joel Pennington, 111, Hatton-garden, London.

27209. **Improvements in dynamo-electric machines.** William Brooks Sayers, Henry Alexander Mavor, William Arthur Coulson, and Samuel Mavor, 46, Lincoln's inn fields London.

DECEMBER 1.

27227. **An improved method of lighting pianofortes by electricity.** Kenneth Barry Ryan Littlestone-on-Sea, Kent

27262 **An improved primary element with interchangeable electrodes and regenerable positive electrodes.** Oscar Rothmund, Edler von Burgwall, and Leopold Ofenschüssel, 18, Fulham-place, Paddington, London. (Complete specification.)

27265. **Improvements in incandescent electric lamps** George Davis, 38, Margravine-gardens, West Kensington, London.

27284 **Improvements in magnetic separators** Victor Isidor Feeny, 60, Queen Victoria-street, London. (Joseph Beals Hamilton, United States.) (Complete specification.)

27301. **Improvements in electric furnaces.** Edgar Field Price, 78, Fleet-street. London.

27304. **Improvements relating to electric arc lamps.** William Reginald Ridings and John Henry Crawford, 124, Chancery-lane, London.

27323. **Improvements in electric arc furnaces.** The Acetylene Illuminating Company, Limited and Percy Crundall Day, 55, Chancery-lane, London.

27344. **An improved mode of mounting filaments in electric glow lamps.** John Archibald Sinclair, 191, Fleet-street, London.

27353. **Improvements in driving apparatus and gear for electrical road or other vehicles.** Edward William Bonson 54, Bellefields-road, Brixton, London.

27354. **An improved electrical switch for power or traction purposes.** Edward William Bonson, 54, Bellefields-road, Brixton, London.

27364. **Improvements relating to safety fuses or fusible cut-outs for electrical circuits and to switches connected therewith.** John William Ewart and Louis John Steele, 11, Southampton-buildings, Chancery-lane, London.

DECEMBER 2.

27376. **Improvements in or relating to electric joints for suspending or supporting electroliers or the like.** William Wilson, 14, Vere-street, Birmingham.

27438. **Improvements in or relating to the application of electric propulsion on railways and tramways** Ladislav Vojacek, 8, Quality-court, Chancery-lane, E.C.

27446. **Improvements in electrical resistance** Rookes Evelyn Bell Crompton, 55, Chancery-lane, London.

27449. **Improved means or apparatus for igniting and extinguishing gas from a distance by means of electricity.** Joseph Denis Cyprien Chateau, 46, Lincoln's-inn fields, London.

27462. **Improvements relating to writing telegraphs.** Philip Arthur Newton. 6, Bream's-buildings, Chancery-lane London. (The Gray European Telautograph Company, United States.)

27464. **Improvements in electrically-driven wool-shearing or hair-clipping machines.** Gershon Bowmar, 1, Queen Victoria-street, London.

DECEMBER 3.

27482. **Improvements in the insulators of electric lamp-holders.** Alfred Watson, jun., 24, Temple-row, Birmingham.

27511. **Improved holder for telephone receivers.** Edmund James Hartshorn and Alfred Jowitt, Sand-street, Aspley, Huddersfield.

27558. **Improvements in electrical signalling apparatus for railways.** William Andrews, 7, Quality-court, Chancery-lane, London.

27578. **Improvements in alternating-current dynamo-electric machines.** John William Ewart, 11, Southampton-buildings, Chancery-lane, London.

27588. **Improved insulating material for electric conductors** Frederick Hawkins, 111, Hatton-garden, London.

DECEMBER 4.

27629. **Improvements in or applicable to ceiling roses for electric lamps.** Everard Acheson, 4, St. Ann's-square, Manchester.

27696. **Improvements relating to electrically-propelled vehicles.** Francis Lauder Muirhead, 124, Chancery-lane.

27695. **Improvements in or relating to the insulation of electric conductors.** Frederick Hawkins, 111, Hatton-gardens, London.

27701. **Improvements in and in connection with the manufacture of electrodes for secondary electric batteries.** Henry Léitner, 37, Chancery-lane, London.

27706. **Improvements in or connected with circuit closers for electric bells.** James Newton, 53, Chancery-lane, London. (Complete specification.)

DECEMBER 5.

27736. **Improvements in conducting arrangements for electric railways and tramways.** Edward Hopkinson, 28, Southampton-buildings, Chancery-lane, London.

27753. **Improvements in electrical measuring apparatus.** William Oliver Smith, George Keith Buller Elphinstone, and Arthur Cecil Heap, 101, St. Martin's-lane, London.

27754. **Improvements in electrical ignition apparatus for oil and gas engines and the like.** Anthony George New, Palace-chambers, Westminster.

SPECIFICATIONS PUBLISHED.

1895.

22233. **Accumulators and their electrode plates, partly applicable to primary batteries.** Engl and Wüste.

24264. **Resistance switch apparatus for starting electromotors.** Siemens Bros. and Co., Limited. (Siemens and Halske.)

24735 **Electric arc lamps or lighting apparatus.** Smith.

1896

64. **Electric tramways or railways.** Krizik.

557. **Electric batteries.** Collins and Cogan.

1842. **Holders for electric glow lamps and analogous electrical contact devices** Kenny.

2199 **Apparatus for transforming alternating into continuous electric currents or conversely.** Imray. (La Société Anonyme pour la transmission de la force par l'Electricité.)

14092. **Electric motors, especially applicable to the propulsion of velocipedes and motorcars.** Clerc and Pingault.

22102. **Electric lighting device for oil-lamps.** Fitzpatrick. (Eckel and Glinicke)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	7⅞-8
Brush Company, Ordinary	3	¾-1⅛
—— Non. Cum., 6 per cent. Pref.	2	1-1¼
—— 4½ per cent. Debenture Stock	100	110-113
—— 4½ per cent. 2nd Debenture Stock	100	96-101
Central London Railway, Ordinary	10	9¾-10¼
——	4	3¾-4¼
Charing Cross and Strand	5	9½-10
Chelsea Electricity Company	5	8-8½
—— 4½ per cent. Debentures	100	114-117
City of London, Ordinary	10	15½-16½
—— 6 per cent. Cumulative Pref.	10	16-17
—— 5 per cent. Debenture Stock	100	128-133
City and South London Railway, Consolidated Ordinary	100	53-55
—— 4 per cent. Debenture Stock	100	126-128
—— 5 per cent. Pref. Shares	10	15¼-15¾
County of London and Brush Provincial Co., Ordinary	10	8-9
—— 6 per cent. Cum. Pref.	10	13¾-14¼
—— 4½ per cent. 2nd Debenture Stock	5	7¼-8¼
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1¾-2¼
—— 5 per cent. Debentures	—	95-100
Edison and Swan United Ordinary	3	1¾-2¼
—— 5 per cent. Debentures	5	3-4
—— 4½ per cent. Debentures	100	103-106
Electric Construction, Limited	2	1⅜-1⅝
—— 7 per cent. Cumulative Pref.	2	2½-3
Elmore's Copper Depositing	2	½-¾
Elmore's Wire Company	2	¼-½
W. T. Henley's Telegraph Works, Ordinary	10	17½-18½
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	109-114
House-to-House Company, Ordinary	5	4½-5
—— 7 per cent. Preference	5	8½-9
India Rubber and Gutta Percha Works	10	20½-21½
—— 4½ per cent. Debentures	100	105-108
Kensington and Knightsbridge Ordinary	5	10-10½
—— 6 per cent. Pref.	5	8¼-8¾
London Electric Supply	5	1-1¼
Metropolitan Electric Supply	10	13-14
—— 4½ per cent. First Mortgage Debenture Stock	100	121-124
National Telephone, Ordinary	5	7-7½
—— 6 per cent. Cum. First Pref.	10	17-19
—— 6 per cent. Cum. Second Pref.	10	17-19
—— 5 per cent. Non. Cum. Third Pref.	5	6⅝-6⅞
—— 3½ per cent. Deb. Stock	100	105-108
Notting Hill Company	10	10-11
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8½-9
—— £4½ shares	4½	7½-8
Oriental Telephone and Electric Company	1	11/16-13/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	103-106
Southampton Electric Company	5	4¾-5¼
St. James's and Pall Mall, Ordinary	5	12-13
—— 7 per cent. Pref.	5	9½-10½
Telegraph Construction and Maintenance	12	39-42
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	6	7¾-8¼
Westminster Electric Supply, Ordinary	5	11-12
Yorkshire House-to-House	5	7½-8

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NOTES.

The Junior Engineers.—There is to be a visit of the Institution of Junior Engineers to the Deptford station of the London Electric Supply Company to-morrow (Saturday) at 3 p.m.

Obituary.—Mr. Alfred Nobel, the inventor of dynamite, has died at San Remo. The idea of sopping up nitro-glycerine with earth does not seem a very great one, but it is difficult to estimate what it has done in the way of facilitating some kinds of blasting work.

The Civil Engineers.—At the ordinary meeting on Tuesday, December 22, at 8 p.m., the paper to be discussed is "Steel Skeleton Construction in Chicago," by Mr. E. C. Shankland, M.I.C.E. There is a students' meeting to-day (Friday), when a paper will be read on "Wells and Well Sinking," by Mr. John W. Kitchin. Mr. Alexr. R. Binnie will preside.

Victoria University.—Among the appointments to vacant external examinerships at the Victoria University, Manchester, are the following: Mathematics—H. F. Baker (Cambridge); engineering—T. Hudson Beare (University College, London); physics—A. W. Reinold (Royal Naval College, Greenwich); chemistry—J. Millar Thomson (King's College, London).

Stoppage.—There was a failure of the electric light over the whole of Cardiff on Saturday night. According to an interview which a representative of one of the local papers had with Mr. Applebee, "the cause of the mishap was a fire on the switchboard," which made it necessary for a time to cut off the supply to the whole town. In about a quarter of an hour the damage was rectified sufficiently to get the light on again.

Motorcarts.—There has been introduced into the Manx Legislature a Bill to legalise the use of light locomotives, more or less on the lines of the English Act. Fourteen miles an hour is fixed as the maximum speed along public highways, and it is provided that yearly duties shall be charged. The papers are full of accounts of motor-cart runs, and there is an occasional account of a break-down, but none of an accident, taking that word in the sense of somebody or something being hurt. For the present, however, we have had enough of the subject.

French Civil Engineers.—Mr. Henri Boucher, the Minister of Commerce, presides at the meeting of the Société des Ingenieurs Civils de France, which takes place yesterday (Thursday) and to-day. Among the subjects for discussion are electrical accumulators, which is introduced by Mr. G. Margaine. The final elections of officers and committee take place this evening. For the presidency the preliminary election gave Mr. E. Lippmann almost, but not quite, an absolute majority, so that he may be practically regarded as already the president for the forthcoming year.

Battersea Polytechnic.—The first meeting of the engineering society founded in connection with the South-West London Polytechnic Institute was held on Saturday, December 12. A lecture was delivered by Prof. Schwartz on "Recent Developments in Electric Supply Stations." Dr. Garnett, M.A., of the Technical Education Board, occupied the chair, and in his opening remarks referred to the good that would be done by such a society. Prof. Schwartz, in his lecture, dealt particularly with the new supply station at Leyton, which the society visit next Saturday, the 19th inst., and which it is well known presents the unusual feature of discarding steam in favour of Dowson gas as a source of power.

The Iron Gates.—It is reported that a project has been seriously started for utilising the power of the Danubian cataracts in the neighbourhood of the Iron Gates. The *Daily Telegraph*, if it chooses, may turn its attention to the matter, as, unlike Niagara, the work is not done, but at present does not appear to have got much farther than proposals made by a Mr. H. Luther to the Servian Government. Some of the details, if correctly reported, look a little queer, but one may reasonably wait for more progress to be made and more details to be obtainable before discussing the practical possibilities of the matter.

An Ideal Sketch.—Dr. C. E. Emery, of the American Institute of Electrical Engineers, has some ideas as to what the high-speed electric locomotive of the future will look like. The motors will be hung on the frame of the engine and be independent of the driving-wheel axles, and the wheels will be big wheels. There will also be a bogie in front; in fact, the electric locomotive will look very like a steam locomotive without the boiler and without a chimney, the latter being an omission which must not fail to be noted, although the "smoke-stack" is not nowadays such a prominent object as it used to be in the early types of American locomotive. It may be, of course, that they will build electric locomotives in that way—such things are done. The original type of railway carriage in this country was simply the bodies of three coaches joined together. But with all respect to Dr. Emery, the type of engine he anticipates will hardly persist.

Telegraphs in Malacca.—At a conference of representatives of the Protected Malay States, the advisability of a junction of the telegraphic system of the Native States with that of Burma through the Malay-Siamese territory was discussed. Such a junction, the *Straits Times* says, would facilitate inter-state communication and inter-state trade, particularly as the Native States lines are to be extended through Johore to Singapore. But such a junction would have more extensive results than these. Burma is connected with the Indian system, and there would thus be established an alternative telegraphic route to Europe, as far as most of the route is concerned, by a land line as against a cable route. The rates from India to Europe are comparatively cheap compared with the rates to Europe from the Straits Settlements, so that in the event of such a junction taking place as that suggested, competition is anticipated, and a consequent reduction in rates.

Meteorological Society.—At the monthly meeting of this society held on Wednesday, at the Institution of Civil Engineers, Mr. E. Mawley, F.R.H.S., president, in the chair, a paper by Dr. Leigh Canney on the "Winter Climate of Egypt" was read by the secretary. The observations of Dr. Leigh were started with the object of arriving by a strictly comparable method at the precise differences between the climates of Upper and Lower Egypt, all previous observations having failed in this respect. Mr. R. H. Curtis also read a paper on an "Attempt to Determine the Velocity Equivalents of Wind Forces Estimated by Beaufort's Scale." The author has compared the anemometric records at Scilly, Fleetwood, Yarmouth, and Holyhead with the wind forces as estimated by the observers at the same or adjoining stations, and has by this method obtained a satisfactory table of velocity equivalents in miles per hour for the estimated forces by Beaufort's scale.

Victorian Exhibition.—On Tuesday the Duke of Cambridge presided at the first meeting of the committee of advice of the Victorian Era Exhibition (Earl's Court), held at the Royal Institute of Painters in Water-Colours,

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Piccadilly. Mr. Crémieu-Javal spoke of the advantages offered by the proposed site of the exhibition at Earl's Court. Sir Stafford Northcote, M.P., Sir C. Kennedy, Mr. MacWhirter, R.A., Sir G. Birdwood, Mr. C. Wyndham, and Mr. W. H. Cummings were present to represent the commercial and industrial, economic, fine arts, historical, dramatic, and musical sections respectively, and the Marquis of Lorne spoke as to a section devoted to women's work. It does not seem quite clear where, if anywhere, electrical work is to come in, but as its development here and abroad is distinctly one of the events of the reign—and, moreover, it is still a subject about which people in general are very ignorant and much interested—it is to be presumed that a place will be found for it somewhere.

Some Forthcoming Events.—To-day (Friday), at noon, is the distribution of the certificates at the Crystal Palace Engineering School. In the evening Mr. McDougall's paper is read at the Junior Engineers. The annual meeting of the French Society of Civil Engineers takes place at Paris. Our own Civil Engineers have a students' meeting, particulars of which are given in another note.—To-morrow (Saturday) the Institution of Junior Engineers have a visit to the Deptford central station of the London Electric Supply Corporation (3 p.m.) and the Battersea Polytechnic engineers visit Leyton. The North-East Coast Engineers also have a meeting at Hartlepool.—On Tuesday, December 22, the Prince of Wales is to open the Davy-Faraday Laboratory at the Royal Institution (3 p.m.), and in the evening the Civil Engineers have a meeting, as to which particulars have been given elsewhere.—Other fixtures for the forthcoming week are of an annual character, and our readers may be trusted to remember them of themselves.

Acetylene.—Last Saturday afternoon, in the Moabit quarter of Berlin, there was an explosion of acetylene gas in the laboratory of Mr. Georg Isaac, a manufacturing chemist, which resulted in the death of Mr. Isaac and three of his assistants. It is part of the irony of fate that Mr. Isaac was engaged in experiments with a view of rendering the storage and handling of acetylene completely safe, and it was so far believed that he had succeeded that he was to have shortly exhibited his results to the Emperor. As all the four people in the laboratory were killed and the place was practically destroyed, the precise circumstances under which the explosion took place will probably never be known, but this affair, following so closely upon the explosion at the Pictet laboratory in Paris, will probably convince people that the chemists were right in saying that, even in the hands of men that know what they are dealing with, acetylene, especially in a compressed form, was a substance which could not be regarded as altogether trustworthy. Even scientific men occasionally forget that if a substance will not explode when you might expect it to do so, it is by no means safe to conclude that it will not go off when you do not expect it.

More Technical Education.—Sir Owen Roberts distributed on Tuesday evening the annual prizes and certificates gained by the students attending the commercial classes of the Regent-street Polytechnic. In the course of a short address Sir Owen Roberts said he was not going to frighten them with the bogey of the German clerk, but went on to say that in order to cope with other countries in commercial enterprise they must study modern languages, which he was glad to see were taught with so much success at the polytechnic. The world was getting very full, and they would have to learn not only French and German, but Spanish, Italian, and Russian. China would some day open up to the enterprising Englishman more than was imagined, and the Chinese language, as well as the Japanese, would have to be studied. Siberia would also have to be reckoned with, and those who learned Russian would be well rewarded.—Why not modern Greek for the Levant, and Arabic? The competition of the Arab trader is a factor in South and East Africa, not to mention the Mohammedan world. Surely this sort of thing has been carried just a little too far. The poor clerk will have no time left to learn spelling and addition.

Railway Museum.—Mr. Clement E. Stretton has forwarded us the full list of the National Railway Museum Committee, which has been formed for the purpose of preserving documents, etc., relating to railway history, and relics. It comprises the Right Hon. Viscount Dalrymple; the Right Hon. J. H. A. Macdonald, P.C., C.B., LL.D., F.R.S.S. (L. and E.), M.I.E.E., Lord Justice-Clerk of Scotland; W. M. Acworth, London, S.W.; A. R. Bennett, London, N.W.; S. R. Blundstone, M.I.M.E., London, W.C.; F. W. Brewer, London, N.; R. H. Burnett, Manchester; P. Caldecott, London, S.W.; C. Chambers, London, S.E.; F. A. Channing, M.P., London, S.W.; J. Sinclair-Fairfax, president Society Patent Agents, London, W.C.; H. Greenly, London, W.; D. H. Littlejohn, M.A., Dundee; F. MacDermont, London, E.C.; Perry F. Nursey, past-president Society of Engineers, London, E.C.; W. B. Paley, London, S.W.; John Ramsbottom, Alderley Edge, Cheshire; C. Rous-Marten, London, S.W.; W. J. Scott, B.A., Sunbury Common; C. Stretton, Leicester; Archibald Sturrock, London, S.W.; A. M. Willcox, London, E.C.; T. Houghton-Wright, Swansea. Hon. joint secretaries: Clement E. Stretton, Leicester, and Norman D. Macdonald, Edinburgh.

Oxygen.—That gaseous oxygen is paramagnetic was a fact early discovered when the phenomena of diamagnetism were first investigated. And in these latter days, when it has come to be liquefied, the way in which the fluid was made to stick to the poles of an electromagnet might easily have led one to infer rashly that liquid oxygen might be magnetic in the sense that the term is applied to iron. From a theoretical point of view, of course, the problem of a strongly magnetic fluid would be a very curious one, but it can hardly be said that there is anything like a real theory as to what actually takes place when iron is magnetised which is so firmly established as to allow one to pronounce *à priori* that a particular phenomenon is impossible. The quantitative results, however, which have been obtained by Prof. Dewar and Prof. Fleming in the course of their investigation of this and other questions connected with low-temperature research have shown that, as might be expected, the magnetic properties of liquid oxygen are relatively feeble when compared with highly magnetic substances. As a result of further work of the same investigators, the magnetic and electric constants of liquid oxygen and liquid air have been correlated—they appear to be very much what they should be—and the measurement and the values obtained were the subject of a paper at yesterday's meeting of the Royal Society.

Physical Society.—Prof. Ayrton presided at last Friday's meeting of the Physical Society. Dr. Chree's paper on "The Applications of Physics and Mathematics to Seismology" was read. Assuming that the substance of the earth is a homogeneous, isotropic, elastic solid [it is not, though in most cases it acts just as though it were], Dr. Chree examined in as general a manner as possible the amounts of flexure which would be produced by different systems of loading. Constants, of course, had to be assumed, but on one very possible assumption a result comes out that the filling and emptying of an estuary or tidal river might deviate a spirit-level or plumb-line by one-tenth of a second of arc. The author also considered

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the effects of the attraction of the sun and moon, producing as they must "tides" in the solid crust of the earth, on the reading of a level, and the measured altitude of a star as obtained with an artificial horizon. On the very vexed subject of the effective elasticity of the earth, the author considers the transmission of earthquake waves to show a Young's modulus which is less than that of iron, but the bulk modulus is very high indeed. Prof. Perry thought Dr. Chree had taken too high values for his constants. Dr. Chree pleaded "Thomson and Tait" as his authority, but appeared not to be quite certain that the really proper way of attacking the question was not by the "equations of pulverulence" of Prof. Karl Pearson and Prof. Boussinesq. Few of our readers will expect us to follow him further here. Mr. Rudel's paper on "Musical Tubes" was, in the absence of the author, read by the secretary. The paper contained some interesting results (the reason, for instance, why church bells are not really musical), and the discussion went off into "overtones" and "partials." The electrical engineer may very possibly be compelled some day to understand all that theory, though not in connection with sound waves. At present it is decidedly outside his province. The next meeting is on January 22.

Householders' Troubles.—Some time ago the Commissioner of Police circulated a warning in which special attention was called to a thief who gained access to houses in the Metropolis on the pretence of inspecting telegraph or electric light wires. (This particular gentleman used to carry a coil of copper wire which, for some reasons inscrutable to ordinary minds, was generally taken as evidence that he really was an electricity man). It would seem, however, that the publication of the warning in the Press was not effectual, for since the notice appeared a number of larcenies of this kind have occurred in London, the thief applying sometimes to inspect electric wires, and sometimes to examine the water cisterns or ventilating pipes. The Commissioner desires "again to warn the public that if householders allow their servants to admit unauthorised persons to their houses on any pretence whatever, they have themselves to blame if they are robbed, and the police can do little or nothing to help them." Probably this last sentence is not intended to mean quite as much as it seems. The real inspector on a surprise visit is trouble enough, but the sham inspector-thief, if the police cannot deal with him, adds a new terror to existence. The sham-electrician thief has caused Mr. J. Atkinson, of Brook-street, W., to call attention to what looks like a real case of wiring trespass. Mr. Atkinson says: "During recent heavy rains I found the wet coming through my top rooms. I sent for the builder, who found a great many of the tiles displaced, and he proved to me that it had been done by someone who had affixed to my chimney stack an electric wire as thick as my little finger. I went to the police station. They said they could not help me, as you must first catch your hare; and eventually was told I must trace the wire to find whose it was. I went out on the roof, but could not trace it, so many being about, and came down as wise as ever. Now, I do think it shameful that one's house is not his own. I never gave permission for this cable to be affixed, and knew nothing of it." What is even more remarkable is the confidence (which appears to be justified) of the unknown fixers of the cable that the aggrieved householder will not simply—well, render the cable useless. If that failed, there are other resources of science available to show where the wire goes to.

Rontgen Radiations.—The New York *Electrical Review* has a seven-column long letter over the signature of Mr. Nikola Tesla, and dealing with the subject of the Röntgen radiations. There is, however, little that is new in it except the following, which we give entire, though with reserve, on account of the eminence of the author: "As to the hurtful actions on the skin, which have been variously reported, I note that they are misinterpreted. These effects have been known to me some time, but I have been unable, on account of pressing matters, to dwell on the subject. They are not due to the Röntgen rays, but merely to the ozone generated in contact with the skin. Nitrous acid may also be responsible to a small extent. The ozone, when abundantly produced, attacks the skin and many organic substances most energetically, the action being no doubt heightened by the heat and moisture of the skin. After exposing the hand, for instance, for some time the skin loses its elasticity, which causes a tension and pain, and subsequently an inflammation and blistering. This occurs mostly only at short range, but may be produced by a single terminal bulb, or generally by a very highly exhausted bulb, in which the terminals act independently at greater distance. Owing to this, I have always taken the precaution when getting impressions with the rays to guard the person by a screen made of aluminium wires, which is connected to the ground, preferably through a condenser. The radical means, however, of preventing such actions is to make impossible the access of the air to the skin while exposing, as, for instance, by immersing in oil. As this would be inconvenient in most cases, a metallic screen should be resorted to. The action of the ozone on some substances when placed near the bulb in such a way that the gas is generated on their surfaces is so powerful that the substances are practically destroyed in a few minutes. When a wire heavily insulated with rubber is connected to the terminal of a high-frequency coil, sometimes an exposure of barely a minute is sufficient to completely wreck the rubber insulation." The formation of ozone by the electric spark is, of course, well known, but some chemical evidence of its production by a Röntgen-ray bulb would have been acceptable. The context shows that it is not the make-and-break which is supposed to do the mischief.

The Hull Extensions.—Either way is often better than no way, and few will doubt that Hull is to be congratulated that the deadlock has come to an end, and the committee's scheme will go through. We have hitherto refrained from comment on the affair, because it seemed eminently a case where comment could do little good. Yet we may remind critics of either side that it is quite possible for a man after having taken every trouble to arrive at a correct judgment to be honestly convinced that he is right, and yet not to have all the right on his side. But there are some general considerations which claim attention. In some places, for instance, the Hull deadlock has been used as an argument against municipal ownership. Now this is simply wide of the mark. The choice lies practically between a municipality and a monopolist company. The man of business who thinks his judgment on technical matters better than the expert officers of the company, and who therefore over-rules their advice, is by no means unknown at board meetings. Only these are private, and the public never hear of it; with a town council they do. It is simply one of these cases where the rule *de non existentibus*, etc., leads one very far astray. Then there is another matter which has a professional bearing. A mechanical contemporary has suggested that at Hull, not only the electric light committee, but also the electric engineer ought to resign forthwith. The suggestion will hardly be received with gratitude in the profession. An engineer's position may often not be altogether a bed of roses, but it will hardly smooth it to make a rule of

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etiquette that whenever his council will not agree with his suggestions the engineer should forthwith resign—and presumably occupy his time in the perusal of the technical papers until an appointment falls vacant under the town council of Sybaris. And there is the other side. Representative institutions may be all wrong, but as things stand the ratepayers would hardly consider that a town councillor had done his work if he confined himself to appointing an expert official of whose qualifications he had only the ordinary means of judging, and thought it his duty thenceforward without further consideration to authorise any expenditure that official suggested. That experts may have sometimes to submit to the judgment of inexperts seems inevitable, and the risk of a wrong judgment must be taken. It is said that even an electrical engineer has at times been known to disregard the expert advice of his medical man.

Society of Engineers. — The forty-third annual general meeting of the Society of Engineers was held on December 14 at the rooms of the society, 17, Victoria-street, Westminster, S.W. The chair was occupied by Mr. Samuel Herbert Cox, president, and the following gentlemen were elected as the council and officers for 1897: as president, Mr. G. Maxwell Lawford; as vice-presidents, Messrs. W. Worby Beaumont, J. Corry Fell, and Henry O'Connor; as ordinary members of council, Messrs. J. Patten Barber, Joseph Bernays, George Burt, D. B. Butler, H. S. H. Farrar, Percy Griffith, Charles Mason, and Stephen Sellon; as hon. secretary and treasurer, Mr. Perry Fairfax Nursey; as hon. auditors, Messrs. Alfred Lass, F.C.A., and Samuel Wood, F.C.A. The forty-third annual dinner of the society took place at the Holborn Restaurant on Wednesday. The president, Mr. Samuel Herbert Cox, occupied the chair, and amongst a large company present were Mr. W. H. M. Christie, F.R.S. (Astronomer Royal), Admiral Colomb, Colonel Cox, Mr. A. J. Walter, Messrs. W. Worby Beaumont, John Corry Fell, and G. Maxwell Lawford (vice-presidents), Messrs. Charles Gandon, W. A. Valon, J.P., and J. W. Wilson, jun. (past-presidents), Messrs. George Burt, D. B. Butler, Percy Griffith, and Charles Mason (members of council), Mr. Perry Fairfax Nursey (hon. secretary and treasurer), Mr. Samuel Wood (hon. auditor), and Mr. G. A. Pryce Cuxson (secretary). The President, in reply to the toast of "Success to the Society of Engineers," alluded to the antiquity of the society, which was founded in 1854, and said that although old age did not invariably carry honours with it, he thought the society was as well preserved and as capable of doing as good work now as in the hey-day of its youth. A study of the *Transactions* showed that there was no falling off in the quality of the papers, and all would agree that so far as the discussions of the papers were concerned, the difficulty was not to find those who were ready to express their opinions, but to enable everyone who wanted to speak the opportunity to do so in the limited time at disposal. During the past year the usual vacation visits had been paid, and the society had to express its thanks to those who had so kindly received them. He regretted that owing to absence from England he had unfortunately been unable to attend these visits, and expressed his thanks to Mr. Maxwell Lawford, the president-elect, for having attended to his duties during his enforced absence, and added that the society was so well organised and possessed such a tower of strength in their secretary, Mr. Pryce Cuxson, that the temporary absence of a president appeared to have very little effect upon its welfare.

The Royal Institution.—The annual prospectus of the Royal Institution has been issued. The following embodies a dated list of the lectures up to Easter: Prof. A. D. Waller, F.R.S., Fullerian Professor of Physiology, will deliver 12 lectures on "Animal Electricity" on Tuesdays, January 19, 26, February 2, 19, 16, 23, March 2, 9, 16, 23, 30, April 8; Prof. H. A. Miers, F.R.S., lectures on "Some Secrets of Crystals" on Thursdays, January 21, 28, February 4; Dr. J. W. Gregory, of the British Museum, lectures on "The Problems of Arctic Geology" on Thursdays, February 11, 18, 25; Dr. Percy Gardiner, Professor of Classical Archæology and Art in the University of Oxford, is to deliver three lectures on "Greek History and Extant Monuments" on Thursdays, March 4, 11, 18; Prof. W. Boyd Dawkins, F.R.S., will give three lectures on "The Relation of Geology to History" (pre-Roman and Roman Britain) on Thursdays, March 25, April 1, 8; Mr. Carl Ambruster delivers three lectures on "Neglected Italian and French Composers" on Saturdays, Jan. 23, 30, Feb. 6; and Mr. W. Frewen Lord three lectures on "The Growth of the Mediterranean Route to the East" on Saturdays. Lastly, Lord Rayleigh, F.R.S., is to give six lectures on "Electricity and Electrical Vibrations" on Saturdays, March 6, 13, 20, 27, April 3, 10. The Friday evening discourses depend in a great measure on the free kindness of eminent men, whose time is subject to the sudden claims of public or professional duty. They are therefore liable to change; but subject to this the arrangements will be as follows: January 22, Prof. Dewar on the "Properties of Liquid Oxygen"; January 29, the Bishop of London on "The Picturesque in History"; February 5, Prof. Jagadis Chunder Bose, M.A., D.Sc., on "The Polarisation of the Electric Ray;" February 12, Prof. J. Milne on "Seismology"; February 19, Dr. G. Johnstone Stoney on "The Approaching Return of the Great Swarm of November Meteors"; February 26, Lieutenant-Colonel C. R. Conder on "Palestine Exploration"; March 5, Mr. Shelford Bidwell on "Curiosities of Vision"; March 12, Prof. A. Smithells on "The Source of Light in Flames"; March 19, Sir E. Maunde Thompson, K.C.B., on "Greek and Latin Palæography"; March 26, Sir William Turner on "Early Man in Scotland"; April 2, Mr. C. T. Heycock on "Metallic Alloys and the Theory of Solution"; and on April 9 a discourse by Lord Rayleigh. The syllabus of Prof. Silvanus Thompson's Christmas lectures on light, to be delivered on December 29 and 31 and January 2, 5, 7, and 9, shows that the lectures run over pretty nearly the whole of physical optics, the Röntgen radiations coming in as the subject of the last lecture. The syllabus is a good enough one, but the task that Prof. Thompson has undertaken of adapting such a subject to the comprehension of a "juvenile auditory" is not exactly a light one. Before Christmas there is, of course, the opening of the Davy-Faraday laboratory, to take place next week.

Science Teaching at Liverpool.—The William Gossage laboratories and the extension of the chemical laboratories of University College, Liverpool, were opened on Saturday by the Earl of Derby. The new buildings include a laboratory, and in the basement an additional lecture-room to seat 70 or 80, a preparation-room, and a gas analysis room. These constitute the William Gossage laboratories. The other new buildings comprise a metallurgical laboratory, a store for apparatus and chemicals, a dynamo-room, electric accumulator room, and a heating chamber. An address was delivered by Prof. Ramsay, in which he contended that better work was done in small laboratories than in very large ones. "In a comparatively small laboratory," he said, "an atmosphere of interest exists. The workers speak to each other in friendly intercourse and criticise each other's work; the influence of seniors on juniors is felt. But in a large laboratory, where the principles of the factory

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supersede the kindly intercourse of friends, where one is lost in labyrinths of passages and puzzled by multiplicity of rooms; where no one knows what his neighbour is doing, nor cares, such advantages are lost. For my part, I prefer the gossip of a village to the county council formalities of a city." So far as possible, students should know how to make their own apparatus or improvise equivalents. Prof. Ramsay added some remarks on the subjeet of the teaching of chemistry, which, however, are equally applicable to all kinds of science teaching. "The theme of chemical education," he said, "has recently been discussed within these walls, but on totally different lines from those I propose to follow. My thesis is that students are, as a rule, much overtaught. I should not regard that laboratory as a chemical heaven where every student had an assistant at his elbow, keeping him on the straight path and guarding him from error. And taking for granted that the object of training students in chemistry is to teach them how to discover new truths, and to form theories concerning the relations between old truths, it is well to adopt the well-known method of trial and failure. A student gains much more knowledge, much more experience, and much more confidence, if, instead of following a printed guide, with a commissionaire at his side to warn him when he goes astray, and to insist on his following the beaten track, he attempts, *proprio motu*, to devise a new method (even when its failure stares in his guardian's face) and tries it. Indeed, there is far too much spoon-feeding." This is vigorously put, and Prof. Ramsay's eminence in the scientific world ought to command for it at least as much attention as is given to the remarks of the average politician speaking about a subject which he does not understand. The crux of the matter, however, lies in the assumption of the final cause of science teaching. There is so usually a mediate and effective cause to be considered—the passing of the "exam." And so long as people continue to look to the list of scholarships and "honours" gained as a test of educational ability, and public and semi-public bodies "cannot, you know, take the responsibility of appointing a man who has no certificates," no amount of talking will much alter matters. Left to himself, a man would rather "research" and make things than "cram" up other people's results to satisfy a syllabus.

Wireless Telegraphy.—Mr. W. H. Preece lectured at Toynbee Hall on Saturday night on the subject of "Telegraphy Without Wires." A great part of the lecture, of course, dealt with elementary matters, and it is to be hoped that the East-Enders duly comprehended it all, but some of the reporters, even with their shorthand to help them, got a little mixed up. Some of Mr. Preece's personal experiences in the matter may, however, be worth reproducing. The idea of telegraphing by induction is, of course, an old one, but before the telephone there was no practical means of carrying it out. In 1884, said Mr. Preece, he was astonished to learn that the operators in the telephone exchange in the City of London who knew the Morse code were able from the sounds heard to read messages that were going through London to Bradford by the telegraph wires. The wires belonging to the Post Office were underground, and those belonging to the Telephone Company overground, and by dint of careful experiments this very fact was found to be the reason why the messages going to Bradford were read by the Telephone Company. Further experiments showed that similar effects could be traced in certain cases on wires separated by as great a distance as 10 miles. After giving further details of various experiments, intentional and unintentional, Mr. Preece said that in 1893 telegrams were transmitted across the Bristol Channel, a distance of three miles, whilst speech was maintained across Loch Ness. In March of last year the cable connecting the Island of Mull with the mainland near Oban having been broken, communication by this means was established pending the arrival of the cable-ship for repairs. Skirting the coast of the island ran an overhead wire well adapted for the purpose; on the mainland a gutta-percha-insulated wire was laid along the ground, earthed in a running stream nearly a mile away from the sea, the other end being in the sea. In the course of four days no fewer than 156 messages were thus despatched—one being a Press message of 120 words. Then the repair of the cable enabled the ordinary method of transmission to be resorted to. The official at Mull reported, "I do not think an ordinary Morse circuit could have given better results." Curiously enough, the chief difficulty was the incessant screaming of the sea fowl, but strong earth currents interfered very much. Mr. Preece then referred to the subject of "magnetic storms" and kindred forms of disturbance, the ultimate source of which might have to be sought for in phenomena occurring as far away as the sun. Returning to practical work, Mr. Preece pointed out that, although it might seem that in wireless telegraphy it would only be possible to have one circuit working at a time, otherwise the messages would get mixed up, that might be avoided by taking advantage of the principle of resonance. The system, however, had proved useless for effecting communication with lightships. Some months ago an attempt was made at considerable expense to communicate between Ramsgate and the North Goodwin lightship by the Evershed method of induction; but the conductivity of the sea-water was too great, and failure was the consequence. It was a disappointment, as preliminary experiments on a small scale had been very promising. Speech had been maintained by telephone through six fathoms of water in Dover Harbour, but became impracticable at the actual distance between the two coils, as the damping effect increased so rapidly with the thickness of water. Mr. Preece then referred to the Marconi experiments. Mr. Marconi, a young Italian electrician, came to him recently, he said, with a system of telegraphy without wires, depending not on electromagnetic but on electrostatic effects—that is to say, on electric waves of a much higher rate of vibration, 250,000,000 a second in fact [*i.e.*, Hertzian waves]. These smaller waves were capable of being projected in one direction only like light, and consequently their power was not so enormously diminished in transmission to any distance. Then came the surprise of the evening, which was nothing less than the first public exhibition of the Marconi apparatus, or rather the outside of the case containing it. Mr. Marconi himself was present and exhibited it. What appeared to be two ordinary boxes were placed at each end of the room, the signal was made in one and a bell immediately rung in the other. Mr. Preece further said that the Post Office had decided to spare no expense in experimenting with the apparatus, and one of the first trials would be from Penarth to an island in the Channel. He might add that he had the greatest faith in the apparatus. The curious thing about it was that there was no new principle introduced. The first man who taught us how to generate these electromagnetic waves was Hertz. But in making practical use of those waves Mr. Marconi had invented devices which were highly novel and very beautiful, and when they were patented and made public he thought they would be admired by everybody. Mr. Preece added that communication in this manner was not affected by either fog or rain, and concluded by referring to the possible services that might be rendered to navigation by this method of communication.

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CHESTER ELECTRICITY WORKS.

Perhaps this ancient city of the Roman occupation has never in all her history been more in line with the spirit of the times than it is to-day. Its Corporation, its officials, its citizens, are eager that the city shall be, as it always has been, in the front rank of those which mark time. It is a

MR. B. C. ROBERTS, J.P., MAYOR OF CHESTER.

beautiful city; its old-world, half timber, Gothic architecture gives it a charm which must be seen to be felt or understood. We think that if the ruins of Melrose are best seen by the light of the moon, the beauties of Chester will be better seen under the light of the electric arc than by any other system of artificial lighting. The authorities of Chester are to be congratulated in having adopted this light, and though we should like to digress to some length upon the ancient history of Chester we must refrain, and plunge *in medias res* of its latest achievement.

The history of the electric lighting scheme dates back some years; in fact, the adoption of electric lighting was discussed some years even before the provisional order was obtained in 1890. Chester owes its electricity supply undertaking just completed to the untiring energies of the present Mayor and Electric Lighting Committee, who have loyally supported the scheme through its many stages of progress. Benjamin Chaffers Roberts, Esq., J.P., now in the second year of his mayoralty, holds the position of chairman of the Electric Lighting Committee. From the period when he succeeded the late W. C. Deeley the scheme has been prosecuted with vigour and expedition, the foundation stone of the generating station buildings being laid by the mayoress in May, 1896, midway in the

MR. S SMITH, TOWN CLERK OF CHESTER.

first year of his office. Owing to the unflagging interest and strenuous endeavours of the Mayor, who has been loyally supported by the Electric Lighting Committee, the public and private lighting of the ancient city of Chester has become an accomplished fact, and we offer to his worship and his co-workers our congratulations on the successful issue of the undertaking. We are pleased to be able to give the portrait of the Mayor of Chester. Our other portrait is that of the town clerk, Samuel Smith, Esq., also an enthusiastic and indefatigable worker in any cause undertaken by the Town Council, judging from what we have from time to time heard. The vexations, delays, and disappointments which have occurred during the various stages of the electric light undertaking would have discouraged, if not deterred, other than conscientious public servants. We also have pleasure in recognising the efforts of the city surveyor, Isaac M. Jones, Esq., and other permanent officials, for so ably seconding the committee and Council to carry out the installation.

THE TOWN HALL, CHESTER.

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At the request of the Town Council some dozen electric light contractors submitted designs, schemes, and estimates for lighting Chester with electricity, and in connection with these schemes the Council have at different periods sought advice from Dr. John Hopkinson, Mr. W. H. Preece, Lord Kelvin, and Prof. Kennedy, whose services as consulting engineer to the Council are now retained. The scheme which has just been carried out to completion was evolved from that submitted by Messrs. Thos. Parker, Limited, of Wolverhampton, in competition with various other firms. It is a unique undertaking in several respects, the station being arranged for supply to a network of mains on a three-wire system fed by feeders, the pressure in houses being 210 volts. The means of regulating the supply by a battery and balancing by a continuous-current transformer in connection with battery is novel in some respects, as will be gathered from what follows.

The compulsory area of supply is that portion of the town within the city walls (see Fig. 1), but mains have already been laid outside this area. Messrs. Thos. Parker, Limited, secured the contract for the supply of the whole of the necessary plant, the conditions being that the contractors should be entirely responsible for the working of the station, and to keep the plant in order and pay all expenses, the station to be handed over to the Corporation at the end of three years or any time before, the Corporation meanwhile guaranteeing a certain demand and paying the contractors in a decreasing ratio according as this demand is exceeded.

The prospects of the station are exceedingly rosy; in fact, the application for the supply of current has been far beyond that anticipated. A supply to an equivalent of 8,000 8-c.p. lamps has been applied for, and other establishments have been wired but not yet connected on to the mains. The present capacity of the plant has already become insufficient to meet demands; the committee have accordingly instructed Prof. Kennedy to make extensions of machinery and plant and to extend the system of mains. Two 400-i.h.p. sets of engines and dynamos are to be added to the plant already installed.

Amongst the buildings being wired may be mentioned the Grosvenor Hotel, Queen's Hotel, Old Bank Buildings, New Blossom Hotel, and the Westminster Hotel. Mr. Rupert, of Stafford, has secured the contract, amounting to something like £2,000, for wiring the Municipal Buildings—a photograph of which we give—comprising town hall, public market, and free library. The market is not shown in our photograph. The market lighting scheme was prepared by Prof. Kennedy and the city surveyor, and provides 36 arc lights of the Crompton-Pochin type, each of 2,000 c.p., for the lighting of the market. The market shops are wired for 94 incandescent lights of 16 c.p. each. About 500 lamps will be fixed in the town hall, of 8 c.p., 16 c.p., and 32 c.p. Electroliers of a special design in brass and iron are being supplied by Messrs. Singers, of Frome, for the Council-chamber, assembly-room, police court, Mayor's parlour, and the committee-rooms. The "rows" and "arcades," for which Chester is so famous, will ultimately be lighted by means of incandescent lamps. Current is supplied to consumers through meters placed in the houses; the meters used being of the Ferranti make.

The price charged per B. T. unit is 6d. for lighting and 4d. for power; meter rents also being charged. Discount at the rate of from £1 per cent. to £5 per cent. is allowed to large consumers, according to the number of units used per annum.

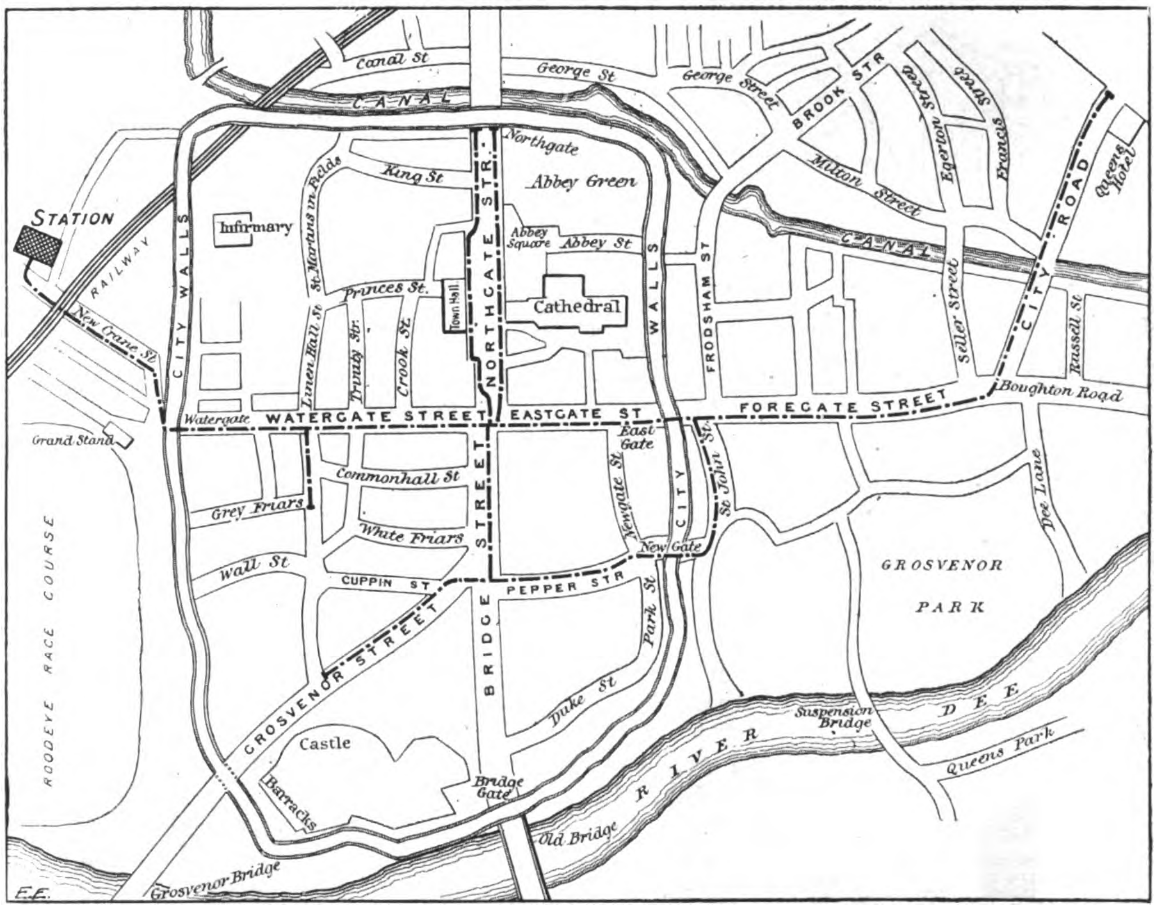

FIG. 1.—Map of Chester, showing Electric Light Mains.

The loan borrowed to defray the cost of the scheme was £25,000, nearly all of which has been expended, the station buildings and plant absorbing about £17,000 of the amount. Mr. G. E. Clarke has been Prof. Kennedy's representative at Chester. Mr. F. Thursfield has looked after the work on behalf of Messrs. Thos. Parker, Limited.

We are indebted to W. H. Matthews Jones, Esq., son of the city surveyor, for the photographs of the interior of the boiler and engine rooms. The exposures were made under very unfavourable circumstances. The atmospheric conditions were bad, and the station, moreover, was in a great state of unpreparedness.

Site of Station

The site, as marked on the accompanying map, is in close proximity to the Chester and Holyhead Railway, and facing Crane-street. Parliamentary sanction to the construction of a coal siding branching from the above railway into the station yard has been refused, and this necessitates carting from the Central Railway Station, which is situate about

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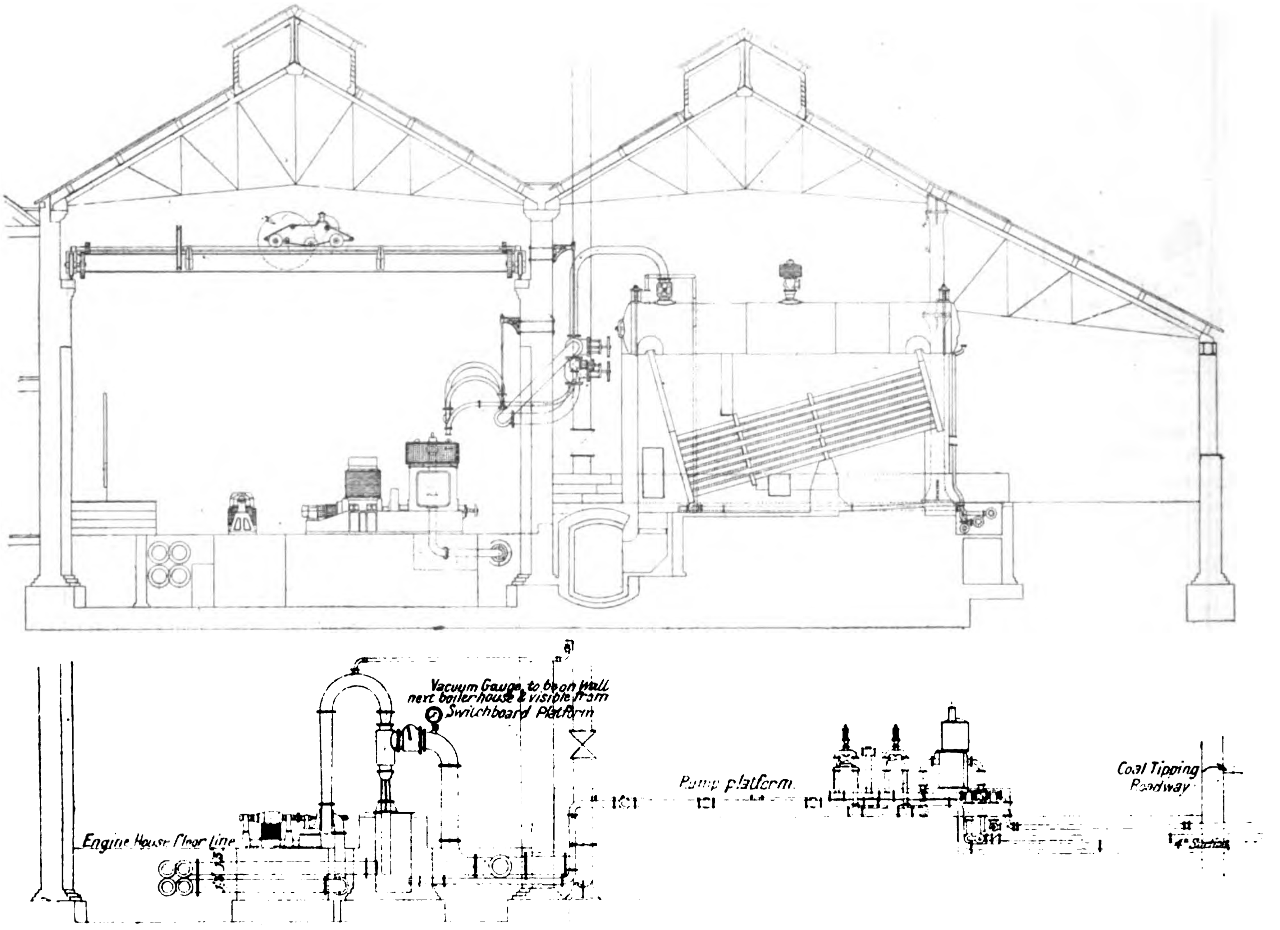
1¼ miles distant. Of course, this means that the price of coal delivered to the station yard is considerably in excess of what would be the case were a siding sanctioned. But notwithstanding this drawback, the cost of coal delivered is still very low. Slack can be delivered at the rate of 6s. per ton, and a better class of coal is expected to average not more than 7s. to 8s. per ton delivered. As will be seen by the accompanying map of the area supplied (Fig. 1), the position of the station with regard to that area is not at all central; it is, in fact, about one-third of a mile or more from the centre of compulsory area. Within convenient distance of the station runs the canal of the Shropshire Union Railway and Canal Company, whence water is taken for condensing purposes. The site affords ample provision for future extension of buildings, should they become necessary.

Station Buildings.

These comprise engine and dynamo room, boiler-house, battery-room, offices, coal-store, and chimney shaft, etc. The dimensions of the principal rooms are as follows: engine and dynamo room, 59ft. by 33ft.; boiler-house, 59ft. by 45ft. 6in.; battery-room, 25ft. by 22ft.; the heights being 33ft., 31ft., and 33ft. respectively. The engineer's and enquiry office, storeroom, and battery-room are situated on the ground floor, while the meter and testing rooms, general offices, and lavatory are on the first floor, the battery-room being continued through first floor to roof. Behind the offices, which face Crane-street, is situated the engine and dynamo room, at the rear of this, again, being the boiler-house. The roof of the former (Fig. 2) is supported on iron principals, and ample provision for light and ventilation is afforded by louvres in the roof and windows of fair proportions in the end walls. The walls are faced with brown salt-glazed bricks to a height of 4ft. 6in., with moulded capping, and above this with ivory-white glazed bricks, the floor being paved with red tiles. A platform is provided at the office side for the switchboard. It is about 4ft. above floor-level, and approached by steps. An eight-ton travelling crane runs the length of the room. The boiler-house provides accommodation for five boilers, but only three are at present fixed. As in the engine-room, the ventilation is by means of louvres. The roof, which is of two spans, is carried on iron principals from walls, and by a row of cast-iron columns in line with boiler-faces. The chief span is of 27ft. Bricks set on edge in cement form the pavement. A couple of large openings at the rear enable coal to be tipped from the yard on to the stoking floor. The battery-room is lined with whitewashed bricks, and the floor is paved with blue chequered Staffordshire bricks set in pitch. Ample ventilation is provided by means of two Boyle's 12in. ventilators. Fig. 4 shows the general plan of these buildings



FIGS. 2 AND 3.—Elevations of the Chester Electric Light Station.

The lofty chimney shaft, which makes the station a conspicuous landmark, is 150ft. in height. At base it is 7ft. square, and the inner lining is of firebrick to a height of 70ft., the internal diameter being 7ft. Difficulties with regard to the foundations for the chimney shaft were met with, for when excavation was commenced evidence was found of an old river bed, water being discovered 5ft. below the surface. Prof. Kennedy made an examination, with the result that it was decided not to excavate further, but to extend the area of the foundation. Concrete was then laid by Prof. Kennedy's orders over an area 35ft. square to a depth of 6ft., a solid mass of concrete, 35ft. by 35ft. by 6ft., being thus obtained. The foundations for both the chimney shaft and the buildings may be termed surface foundations. However, the plan adopted in lieu of driving in piles has apparently met the difficulty successfully, notwithstanding the treacherous nature of the soil, for the buildings have shown no signs of settlement, and the test of perpendicularity which the shaft was submitted to proved very satisfactory. Owing to this difficulty in connection with the foundations, the buildings are raised slightly above the original level intended, and the flues from the boilers are necessarily carried into the chimney shaft above the intended level, but the alteration has otherwise made little material difference to the designs. The chimney shaft contains some 1,050 tons of material, and is surmounted with a cast-iron circular moulded cap, supplied by Messrs. Smith, of Whitchurch, who also supplied the iron columns and roof supports, etc. in connection with the buildings. A lightning-conductor

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of copper tape, 1in. by ⅛in., connected with the iron cap, and with a solid copper plate embedded in coke at its lower extremity, has also been fixed. In concluding these few remarks on the building, we may add that the front elevation is of Ruabon pressed bricks dressed with stone; to give the front elevation a pleasing appearance. Mr. Thomas Browne, builder, Chester, was the contractor for the buildings, and his contract, besides the erection of the buildings, included chimney shaft and foundations.

The wiring of the buildings and offices for electric

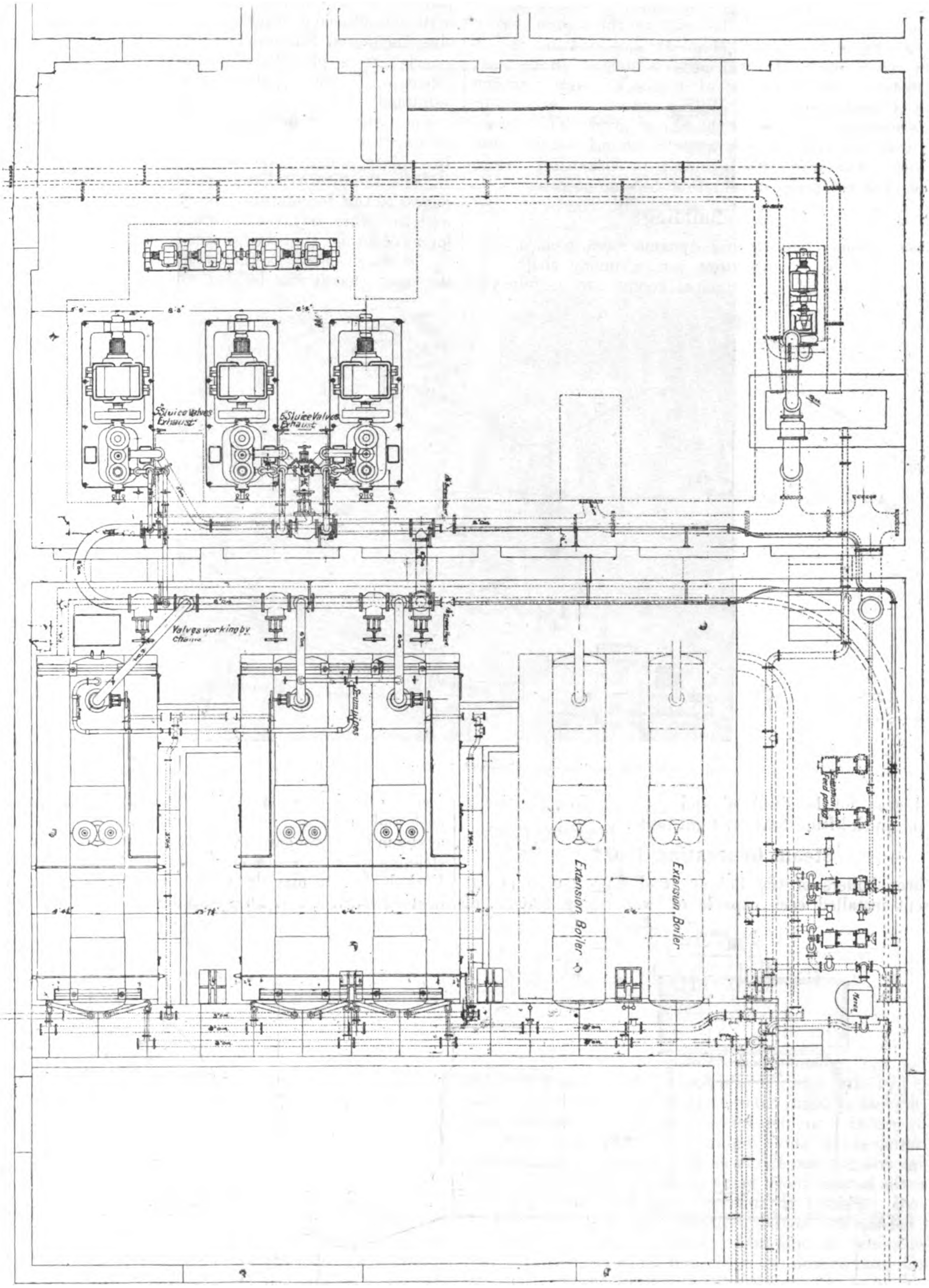

FIG. 4.—General Plan of the Station.

lighting was carried out by the Walsall Electric Company, who supplied all the fittings. Some 50 16-c.p. lamps were installed, and five 32-c.p., while three 100-c.p. lamps are used to light the engine-room.

The clerk of the works superintending the construction of the buildings on behalf of the Corporation was Mr. Helms.

also that the roof glazing throughout is on Helliwell's patent system.

The architects for the buildings were Messrs. Davies and Sons, of Chester, and the design is in every respects creditable to the firm—a substantial structure has been erected of an eminently practical design, without undue extravagance, and yet with sufficient architecture combined

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Traveller.

An overhead travelling crane, supplied by Messrs. Carrick and Ritchie, of Edinburgh, traverses the length of the engine and dynamo room. It has been designed for a working load of eight tons, and is provided with the usual gear for longitudinal and cross motion, besides a special quick-lifting gear for light loads.

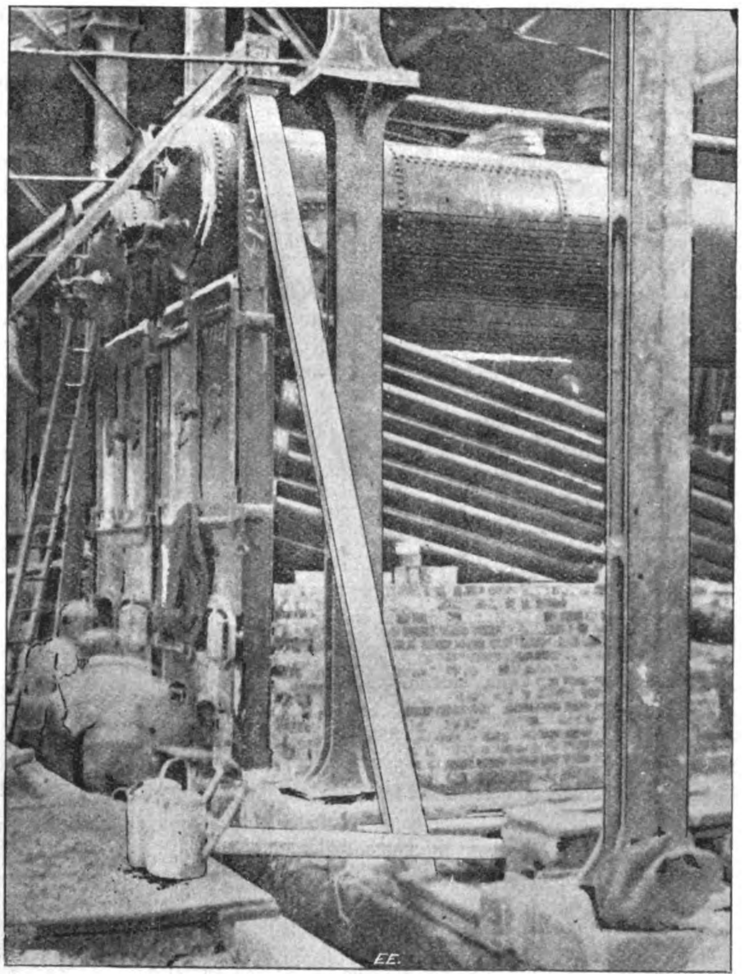
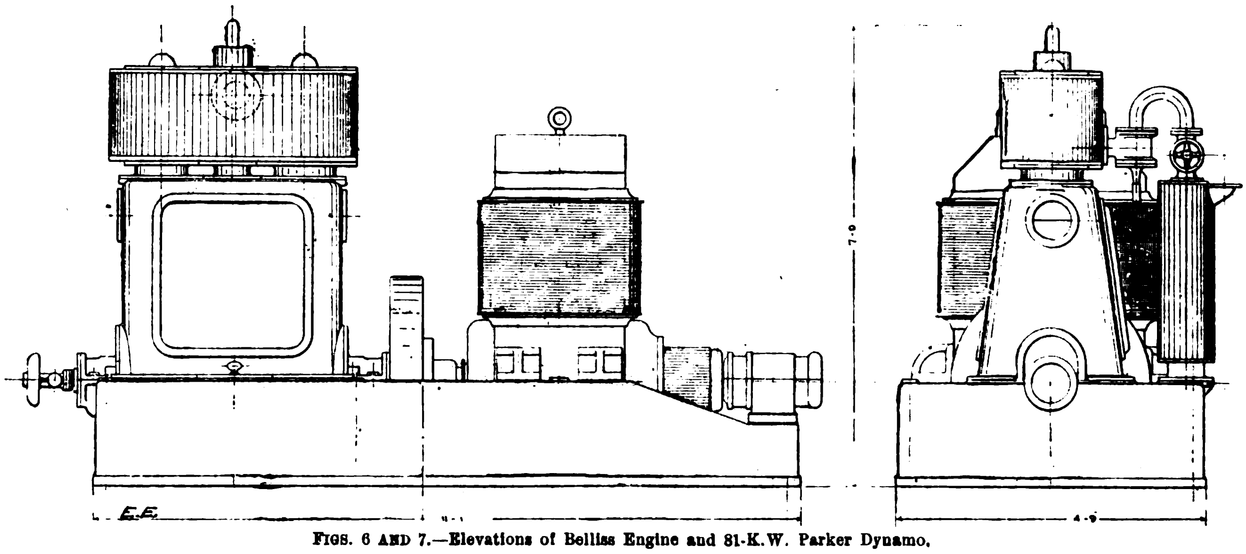


FIG 5.—View of Boilers and Seating in course of Erection.

Steam Generating Plant.

Three boilers of the Babcock and Wilcox type are at present installed, each capable of evaporating 5,000lb. of water per hour at a working pressure of 160lb. per square inch, which, in fact, will be the rate of working under normal conditions. The steam-drums of these boilers are of steel plate, the tubes being of wrought iron, lap-welded, and connected at ends with steel headers. The fittings throughout have been supplied by Messrs. Alex. Turnbull and Co., of Glasgow, and include for each boiler a steam stop-valve 6in. internal diameter, a safety-valve arranged to carry off steam without allowing pressure to rise more than 5lb. above pressure, at which the valve is set to blow off; duplicate feed check-valves and duplicate feed stop-valves, each of 2in. internal diameter; a scum-cock and drain-pipe; a blow-off valve 2in. internal diameter; a steam-pressure gauge; a stop-valve ¾in. diameter for cleaning pipe connections; and two glass water-gauges. Each boiler, it may be added, has 1,619 square feet of heating surface, and an hydraulic test of 250lb. pressure per square inch was applied before delivery. The foundations consist of 7ft. of concrete. The main flue is 7ft. by 6ft., and passes along at the back of boilers, and is intercepted by an economiser; but a by-pass to chimney shaft is also provided. These flues, together with the economiser flues and by-pass, are lined with firebricks. The grate area of



FIGS. 6 AND 7.—Elevations of Belliss Engine and 81-K.W. Parker Dynamo.

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these boilers is 30 square feet. Each boiler is composed of eight sections, nine tubes high, the tubes being 4in. diameter and 18ft. long, the headers being of wrought mild steel. The steam and water drums are 42in. in diameter.

A fuel economiser of 144 tubes has been supplied by E. Green and Son, Limited, of Manchester and Wakefield, and is of their high-pressure type, being fitted throughout with patent internal lids, and all flanges strengthened. An improved method of admitting the feed water, recently patented by the makers, has been applied to the economiser under notice for the prevention of external corrosion taking place on the vertical tubes when feeding with water at a low temperature. The water enters by the top branch pipe at the coldest end and passes downwards through the first few rows of tubes, the flow being evenly distributed by means of nozzles placed at the top of each. This arrangement has been found to act very successfully and to considerably increase the durability of economisers working under the conditions indicated. The economiser is designed to heat 1,000 gallons of water per hour from 60deg. to 200deg. F., and to work under a pressure of 160lb. per square inch. The scrapers are worked by means of a small electric motor of about ½ h.p.

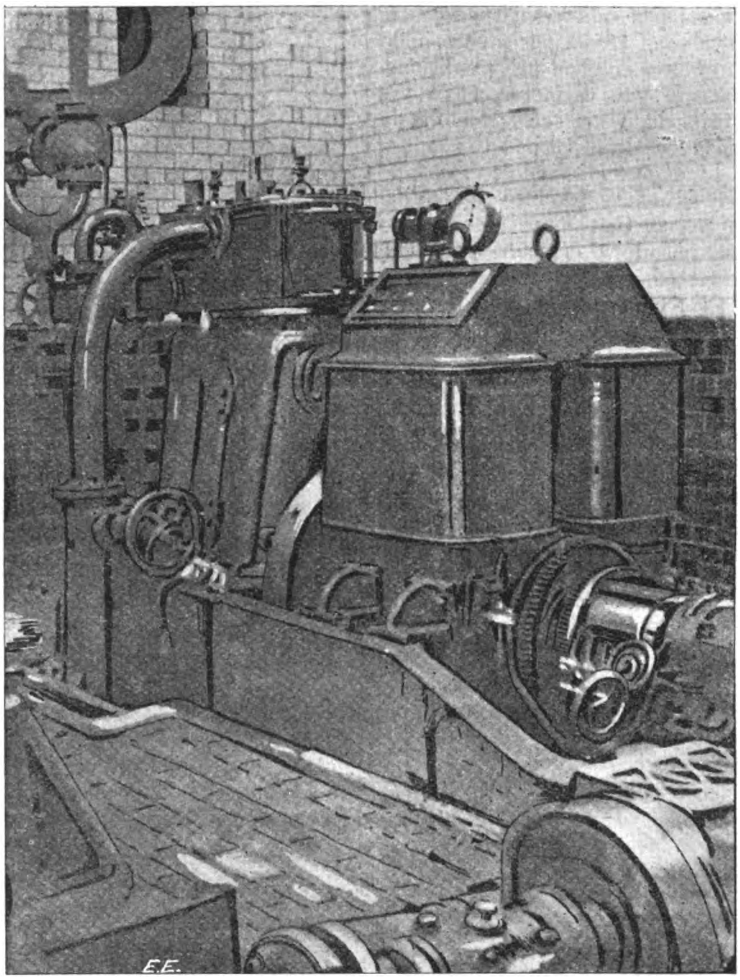

Fig. 8.—View of 81-K.W. Steam Dynamo.

Feeding Gear.

A feed-water tank is placed in close proximity to the chimney shaft, receiving its supply from the water company's mains, but it is also connected with the condenser discharge pipe. Two feed-pumps of Tangye's duplex pattern (Fig. 3), each capable of delivering to the boilers 1,500 gallons per hour, are situated in the boiler-house. These are carried on steel joists about 2ft. above the level of the stoking floor, and a chase runs along the front of the boilers and at the side of the flues for carrying the feed and blow-off pipes. The feed-pipe service provides complete duplication from the pumps to the economiser; from the economiser feed-pipes in boiler-house; also from the pumps to the boiler direct. The pumps deliver to two lines of 'bus pipes, and are arranged to take steam from either of the main ranges of steam-pipes. All the feed-pipes are of copper, with faced steel flanges and tees of cast iron. As will be gathered from the above remarks, the system of feed-pipes is very elaborate; every precaution has been taken, in fact, to avoid possibility of a breakdown.

Steam and Exhaust Pipes.

The steam-pipes, as shown in Figs. 3 and 4, are arranged on the ring principle, with loops to engines and direct branches to boilers, and valves are so placed to enable any one engine or boiler to be cut out independently of the others. The main line is composed of steel lap-welded pipes of 8in. diameter suspended by rods to give flexibility. All bends smaller than 6in. diameter are of solid-drawn copper with wrought-iron steel flanges brazed on. The pipes to engines are also of copper, with turned flanges and joints, all steam joints being made with corrugated gunmetal rings and mastic cement. Ample provision for drainage is provided by steam separators. All steam-pipes were subjected to an hydraulic test of 350lb. pressure per square inch before being accepted. Alternative means of exhaust are provided: either through the condenser or direct into the atmosphere. The exhaust pipes are of cast iron, 15in. internal diameter. An improved exhaust sluice-valve is provided for each engine. We may add here that the steel steam-pipes were supplied by Messrs. J. Russell and Co., of Wednesbury; the cast-iron pipes by Messrs. J. S. Roberts and Co., of West Bromwich; the copper pipes and bends by Messrs. Isaac Stoor and Co., of Manchester; the steam-valves throughout have been supplied by Messrs. Alex. Turnbull and Co., of Glasgow; while McDougall steam-traps are used, supplied by Messrs. W. B. Haigh and Co. It may be mentioned also that the steam-pipes have been covered with magnesia non-conducting material, supplied by the Washington Chemical Company.

The ejector condenser plant, supplied by Messrs. Körting Bros., of Westminster, is capable of condensing

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10,000lb. of steam per hour, with a vacuum equal to 24in. of mercury in main exhaust. The water for condensing, as previously mentioned, is obtained from the contiguous canal of the Shropshire Union Railway and Canal Company, the connections to the condenser being four cast-iron pipes of 9in. internal diameter. A centrifugal pump is connected with the condenser capable of discharging 700 gallons of water per minute to a height of 20ft. above suction-pipe. It is driven by an electric motor (direct coupled) supplied by Messrs. Parker, Limited. The combined plant is situated in the engine and dynamo room on one bedplate, and automatic lubrication is provided for all bearings. The motor is wound for 440 volts, and has been designed for a wide range of speed to suit the condition of working. Its starting switch, regulating resistances, etc., are controlled from the switchboard.

Engines.

These were manufactured by Messrs. G. E. Belliss and Co., of Birmingham. The engines are three in number, designed to indicate continuously 135 h.p. when running at a speed of 380 revolutions per minute, with a steam pressure at the engine stop-valve of 150lb. per square inch, under either condensing or non-condensing conditions. The high-pressure cylinders are 9in. diameter, while the low-pressure cylinders are 15in. diameter, the stroke being 9in. We have several times recently described the Belliss two-crank compound type of engine of similar design to those at Chester, so it is needless to go into a detailed description now; suffice it to say that forced lubrication is provided, and the engines are coupled direct to dynamos. The combined sets were tested under the supervision of Prof. Kennedy at full, three-quarter, and half loads before being delivered. The sets were run for six hours under full load with highly satisfactory results, and we understand are running equally well at the station. The tests were made under condensing conditions, and by the courtesy of Messrs. Belliss and Co. we are enabled to give full particulars of the tests as under. The engines shown in elevation in Figs. 6 and 7 and in perspective in Fig. 8 are coupled direct by flanged coupling to the dynamos.

CONDITIONS OF TESTS.—CHESTER ELECTRIC LIGHTING.

Belliss's enclosed self-lubricating compound engine. Parker's, Limited, continuous-current dynamo. Steam pressure, 150lb. per square inch. Revolutions. 380 per minute. Amperes, 184. Volts, 440. Diameter of cylinders, high-pressure, 9in. ; low-pressure, 15in. by 9in. stroke.

Steam at boiler.	Steam at engine.	Vacuum.	Revolutions.	Amperes.	Volts.	E.H.P.	I.H.P.	E.H.P. / I.H.P.	Water per I H.P.	Water per E.H.P.
*152·8	122·8	27·72″	385	185·04	439·72	109·04	124·24	87·78%	17·15	19·55
†154·4	97	28″	385	138·2	440·2	81·6	95·37	85·5%	17·38	20·3
‡150 3	65	28″	384·3	94	442·16	55 7	69·375	80·2%	18·75	23·36

* Full load average of six hours' readings. † Three-quarter load average of 1 hour 5 minutes' readings. ‡ Half-load average of 1 hour 5 minutes' readings.

Dynamos.

Three dynamos are at present installed, each identical in design, giving 184 amperes at 440 volts pressure at 380 revolutions per minute. They are driven direct, and each engine and dynamo has a common bedplate, with a foundation of concrete 5ft. thick. The machines are of Messrs. Parker's shunt-wound continuous-current type, with drum armatures, Eickmeyer wound, the field magnets being of the two-pole horseshoe inverted pattern, armature below magnets. The magnets and pole-pieces are of cast steel, carried on cradles of a special design, to facilitate examination or repair of armatures, the pole-pieces being cut through on the horizontal axis above the point where supported by the cradles, thus allowing the whole top half of the field magnets to be lifted bodily clear of the armature. The armatures have cores of charcoal-iron discs separated by paper, and are so arranged that they can be lifted out for repairs, after the field magnets have been removed, by a direct vertical lift. Another interesting feature of these machines is that the brush pillars are carried by a rocking gear, which can either be worked by hand or by a worm and wheel attachment, for fine adjustment. Each machine is self-excited, and capable of running steadily at any E.M.F. of from 420 to 450 volts at normal speed. A resistance is placed in the shunt circuit of each dynamo field, the regulating switches being placed on a rail in front of the switchboard. The leads are taken to the switchboard in separate iron pipes laid under the surface of the floor. It was stipulated that the combined efficiency of each dynamo and engine should not be less than 81 per cent., which figure is much below the efficiency actually obtained—*i.e.*, 87·78 per cent.

Besides the three dynamos described above there are three other machines—viz., a balancing transformer, consisting of two balancing armatures direct-connected, and two charging dynamos, or boosters, also coupled by flange couplings to the balancing transformer. The latter is connected across the outer mains of the three-wire system at the switchboard omnibus bars. The middle wire is connected to the common terminal of the two armatures. This transformer is capable of balancing the whole system when any current up to 100 amperes in either direction passes through the middle wire. The shafts of the three machines being coupled together, the combined machine runs as one, the balancing armatures driving the two boosters as generators, the latter giving a maximum output of 50 amperes at 70 volts. These boosters are designed to give an E.M.F. of from 10 to 70 volts on open circuit with any current between 0 and 50 amperes. The flange coupling mentioned above is capable of easy disconnection. It may be mentioned that all commutators are of copper insulated with mica, and lubrication, both in the case of the large and small machines, is by means of ring lubricators. Five feet of solid concrete form an efficient foundation for the boosters and transformers.

Accumulators.

There are two batteries, each of 115 cells. The cells are of the E.P.S. 25-plate K type in glass boxes, each having a normal capacity of 300 ampere-hours, and designed to give without injury or undue waste in recharging the following discharges: 60 amperes for five hours, 80 amperes for three hours, 120 amperes for 30 minutes, these results being obtained with the temperature of the electrolyte at 55deg. F. The cells are supported on oil insulators carried by dry wood bearers, the plates being separated by three glass tube separators. They are arranged in double parallel rows in two tiers, access being obtained to the upper cells by means of raised platforms running between each row. The batteries are connected to the boosters and switchboard are explained elsewhere.

Switchboard and Method of Working.

The switchboard (Fig. 9) has been supplied by Messrs. Thomas Parker, Limited, of Wolverhampton, and consists of three panels of enamelled slate supported on an iron framework. It is arranged for three dynamos, three feeders, two batteries, one balancing transformer, two boosters, and a three-wire system of distribution, the middle wire being permanently connected to earth. The accompanying diagram will give a rough idea of the board. The centre panel contains the battery, balancing transformer, and booster instruments and switches. The negative instruments are situated on the right-hand outside panel and the positive on the left, the feeders being at the top of the board. On a handrail in front of the board, switches for regulating the fields of the dynamos and balancing transformer are placed; the resistances which they communicate with are under the switchboard platform. The switches for regulating the boosters and starting the balancing transformer form part of the main switchboard. In the circuit of each dynamo are the following instruments: an automatic zero cut-out switch, fitted with fuse to blow at 300 amperes, and an ammeter reading up to 200 amperes; also two terminals are provided to enable connection being made either through the automatic switch or direct to dynamo bar. In circuit with the feeders are two duplex fuses, each to carry 500 amperes and two ammeters graduated to 500 amperes. Three feeder bars are placed

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vertically on the front of each outer panel, and between these are placed alternately the dynamo bars. In each battery circuit is a regulating switch of special design interlocked with booster reversing switch, a battery ammeter reading up to 200 amperes, an emergency switch for cutting the battery out of circuit, and two registering meters reading direct in ampere-hours. The balancing transformer is in circuit with a duplex starting switch, an ammeter reading to 150 amperes, and also a middle wire ammeter. The booster circuits are provided with an ammeter graduated up to 100 amperes; a pair of omnibus bars for plugging the secondary on to the battery circuit, the milking leads, or the meter test circuit; a reversing switch enables the E.M.F. of the booster to be added to that at the 'bus bars for charging the battery, or on discharge the booster E.M.F. can be added to that of the battery when the 'bus bars are at a higher E.M.F. than the battery. A voltmeter, with multiple contact switch, is also provided. At the back of the outer panels are placed a couple of 'bus bars 2in. wide by $\frac{5}{8}$in. thick, and 15 main switchboard plugs are provided. The of the battery would be sufficient to cope with the public lighting together with private lighting, as the public arcs remain alight from sunset to sunrise.

The Mains.

The whole of the cables have been manufactured and laid by the Callender's Cable and Construction Company, Limited, of London and Erith, who have also carried out the whole of the street work, including the excavation and repaving, and the erection of the arc lamps and brackets. The cables used are concentric, lead-sheathed, and steel-armoured. They are insulated by bitumenised fibre between the conductors and over the outer conductor, the armouring consisting of two steel tapes protected by a final yarn well compounded, and as an additional safeguard tarred boards have been placed in the trenches over the run of the cables wherever the mains are in the road. These boards are intended to serve as an indication to workmen in the future of the presence of the cables underneath.

The distributing network consists of triple concentric cables, laid in all the principal streets in the city, as shown

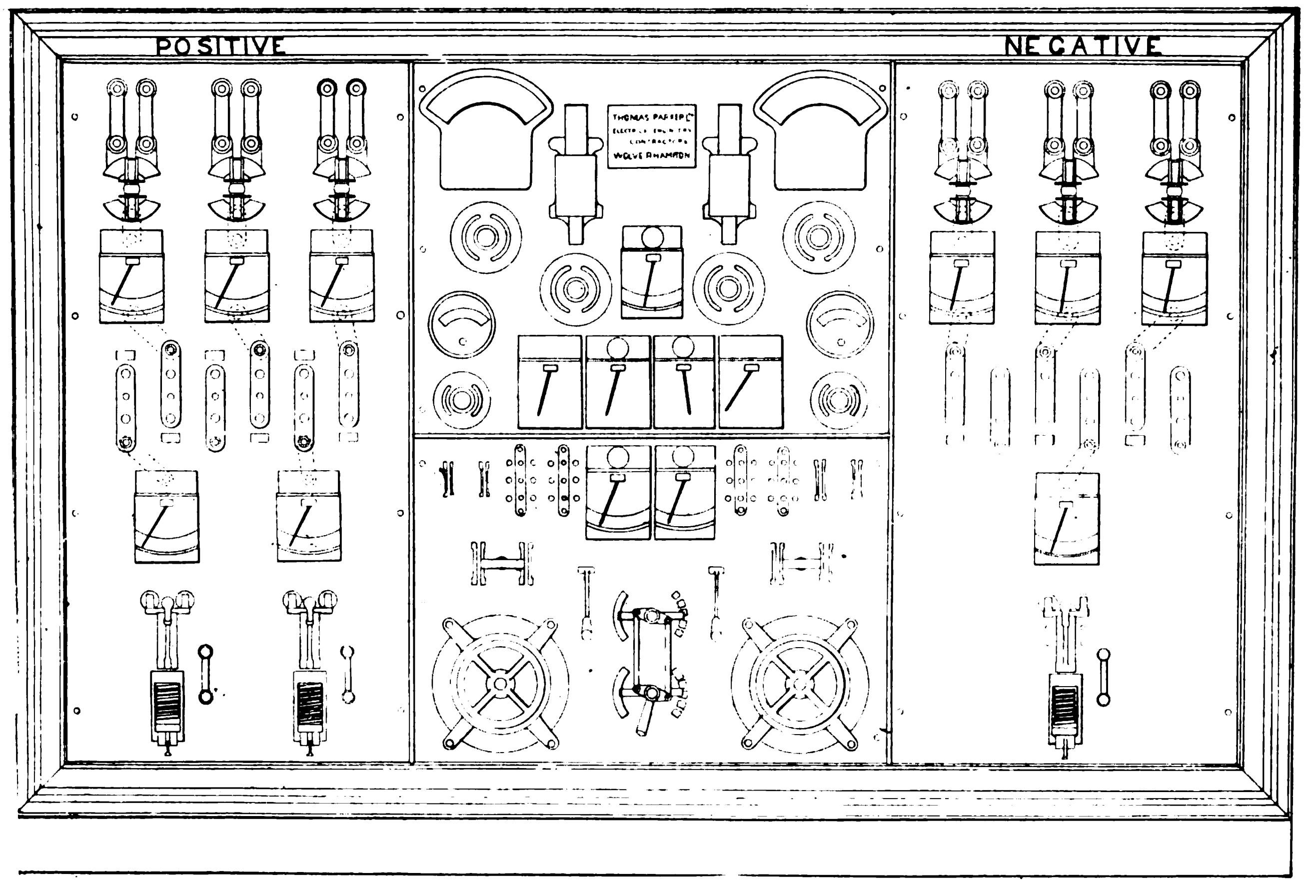

FIG. 9.—Elevation of Switchboard at Chester.

dynamos can be run in parallel or separately on the feeders as may be desired. By means of the above arrangement of the boosters they can be made to supply extra E.M.F. for charging the batteries, or can be connected in series with the batteries to hitch up when discharging. It may also be mentioned that there are nine reserve cells in each battery, which can be switched in from the switchboard as required. All switchboard connections are of copper, but the battery fittings are of brass, painted with anti-sulphuric enamel—blue for positive connections and red for negatives. We mention this because it is contrary to usual custom, and might be confusing. The feeder voltmeters on switchboard are of the Weston pattern, while the voltmeters used for the 'bus bars and dynamos are of the Kelvin electrostatic type. The ammeters are Kelvin instruments, and the battery meter is of Thomson-Houston make. The battery will always be kept in circuit to act as a regulator. The system of working has not been finally decided, but it is probable that the accumulators will be charged during light load. They will not be depended upon, however, to supply the night demand unaided, for it is doubtful whether the present capacity in the plan (Fig. 1). Two sizes of cables are used, one of them having the conductors ·10 square inch, ·06 square inch, ·10 square inch, and the other ·06 square inch, ·06 square inch, ·06 square inch; the neutral wire of the network is placed as the outer conductor of the cables. This network is connected with the station by means of two feeders, each consisting of a two-conductor concentric cable, each conductor being of ·50 square inch. These feeder mains are run as far as the Cross, where they terminate in a large dividing box, from which five sub-feeders are run to the feeding points on the network. These sub-feeders are two-conductor concentric cable, each of ·25 square inch section. The connection between the neutral wire of the network and the station is made by a single-conductor cable ·25 square inch in section, which joins into the network at a specially constructed box close to the Cross. Pilot wires run from each sub-feeder box direct back to the station, and these pilot wires consist of three-core cable, each conductor being separately insulated and being of ·008 square inch section.

(Continued on page 691.)

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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THE BRISTOL TRAMWAYS.

The supply of expert reports on the question of Bristol tramways still keeps up, and there is evidently a very strong local feeling on the subject. Our readers have been kept informed of the state of the controversy in our columns of "Business Notes." The report of Mr. H. F. Parshall to the tramway company and the opinions of Dr. John Hopkinson and Lord Kelvin are printed elsewhere in this issue. The facts are briefly as follows: The electrically-equipped line from Bristol to Kingswood has been a success both from the public and the tramway company's points of view. The company therefore wish to convert practically all the rest of the tramways in Bristol into electric lines, and applied to the Corporation for their consent. Mr. W. H. Preece was called in by the Traction Committee to advise them on the matter, and reported at length. These recommendations were to the effect that the sanction should not be given unless the power required is taken from the Corporation. The committee in question added other restrictive clauses in their report to the Council, one being that the sanction for the trolley construction should only hold good for five years. The report of this committee has practically been adopted by the Council by a majority of thirty-one to twenty-one votes. Hence the matter will have to be thrashed out before Parliament when the tramway company's Bill comes up for discussion. The speeches on the question at the last meeting of the Bristol Town Council showed that both sides had a grip of the real matter at issue. We take the primary question at issue to be how far the present tendency towards municipalisation can lead us with advantage. We hold that the supply of water, electric light, and gas, and other necessities should be under the control of the town, but hardly see why the authorities should undertake the supply and working of tramways, 'buses, cabs, and parcel deliveries. It is round this perhaps abstract point that the matter turns, but the practical details have given grounds for a conflict between experts. Mr. Preece naturally concludes that by the charges made for the supply of power to the tramway company the Corporation will be able to relieve the electric lighting department of part of its standing charges. The opposition report by Mr. Parshall shows that the company does not wish a profit to be made by the Corporation out of the supply of power. He doubts that economy would result from the combination of power and light, and states that "the lighting machinery now installed could not in any case be used in place of the machines required for the electric traction work. The two plants would have to be separate and distinct." The same idea is expressed in the two confirmatory opinions. Yet Mr. Parshall used a very similar plant to supply the feeders on the Dublin-Dalkey line. The alternate-current generators were certainly three-phase; but a single-phase synchronous system would also have served the purpose. It is our opinion, in spite of the authorities arrayed against us, that economy in

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the actual cost of power should result from the combination of the two schemes if under able control. The coal supplies and steam generating plant could at least be shared, and with forethought the generating plant could also be made to give mutual assistance on emergencies. The only question is whether the dual supply at Bristol would give such an economy, or whether the Corporation would, by increasing the capital outlay and working expenses, nullify the possible saving. The idea that this will be the case justifies the experts in their conclusions. In the other points at issue the Corporation are certainly acting in an arbitrary manner. It is absurd to expect a company to regrade their streets for them and to erect an overhead system of electric traction on a five-year license. It would be utterly impossible to get the necessary capital under such restrictions.

THE ANNUAL MEETING.

The first annual meeting of the Institution of Electrical Engineers under the amended articles of association was held last week. The attendance was restricted to members and associates of the Institution, and a very fair number were present. The discussion before the report of the Council was adopted showed the value of the alterations in the constitution. Previously no discussion was possible without moving an amendment to the report. As such an amendment was usually taken as a censure on the Council few suggestions were made, and the annual meeting did not give the member his due voice in the control of affairs. From our report of this year's meeting it will be seen that there was no dearth of suggestions. Perhaps an unduly large proportion of these had reference to the best way of providing more attractions at the conversazione. Still, other speakers had the primary object of the Institution in view, and their proposals tended towards raising its status in the engineering world. When only one paper of all those read in a session is worthy of a premium, some decided move is required to remedy the matter. While not concurring with the idea that the secretary should invite papers on his own responsibility, we think that a general invitation stating on what subjects papers are most urgently required should be sent to all members, as is done by the Institution of Civil Engineers. In special cases additional pressure might be brought to bear, but if the members and associates will only take an active interest in their society, such a course will very seldom be necessary. No one raised the question as to the reading of papers in abstract, which we think to be a reform urgently required. The full proofs of the papers can, as a rule, be obtained beforehand by those who wish to take part in the discussion. Thus by reading an abstract only, much valuable time could be saved and time given for more papers per session.

The E M.F. of a Thermo-Couple.—In a paper recently read before the Paris Academy of Sciences on "The Influence of Magnetisation upon the E.M F. of a Thermo-couple, of which Iron is one of the Elements," by Messrs. U. Lala and A. Fournier, it has been stated that a diminution of the E M.F. was observed to take place when the couple was placed in a strong magnetic field.

CHESTER ELECTRICITY WORKS.

(Concluded from page 689.)

The feeder, network, and other boxes are of a special design, and are so arranged that, whilst all the ends of the cable are securely protected, and quite out of the reach of any damp or moisture, any line or section coming into the boxes can be readily disconnected. Consumers are joined to the mains by cast-iron service

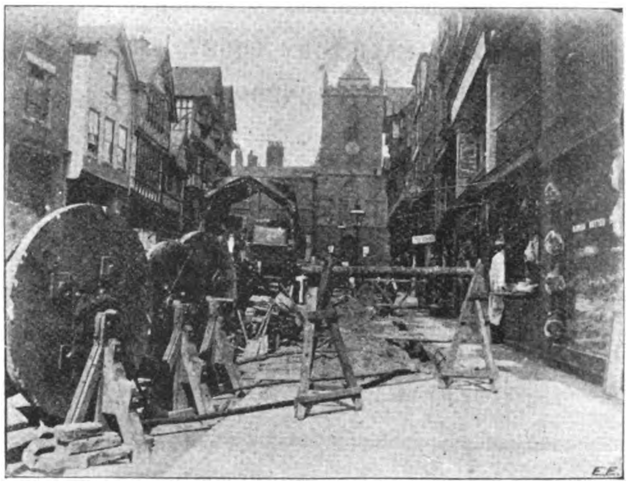

FIG 10.—Main-Laying at Chester.

boxes fitting on the mains, and the branch leading from the distributors into the consumer's premises consists of concentric armoured cable, similar to the mains themselves. These cables end in one of Reid's patent fuse and cut-out boxes, which is fastened on a suitable board attached to the walls in the consumer's premises. The arc lamps are supplied by single-conductor cable across the two

FIG. 11.—View of Cables in Trench.

outers of the three-wire system. Mr. A. Burton superintended the laying of the mains. The following are the lengths of cable supplied :

Area, square inch.	Type.	Length.	Use.
·5 ...	Concentric ...	1 500 yards ...	Main feeder.
25 ..	Single	750 ,, ...	Neutral feeder.
·25 ...	Concentric ...	625 ,, ...	Sub-feeder.
·35 ...	,, ...	850 ,, ...	,,
·1, ·06, ·1 ..	Triple conc. ...	1,400 ,, ...	Distributor.
·06, ·06, ·06 ...	,, ..	3,500 ,, ...	,,
3-core, 7/21 ...	— ...	3,400 ,, ..	Pilot.
7/16 ...	Single	5,400 ,, ...	Arc cable.

The two accompanying illustrations (Figs. 10 and 11) show the process of main-laying in Chester. Fig. 10 gives

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a good idea of the characteristic architecture in this quaint old town.

Public Lighting.

At present 48 arc lamps have been erected in the principal streets. They are carried on standards 22ft.

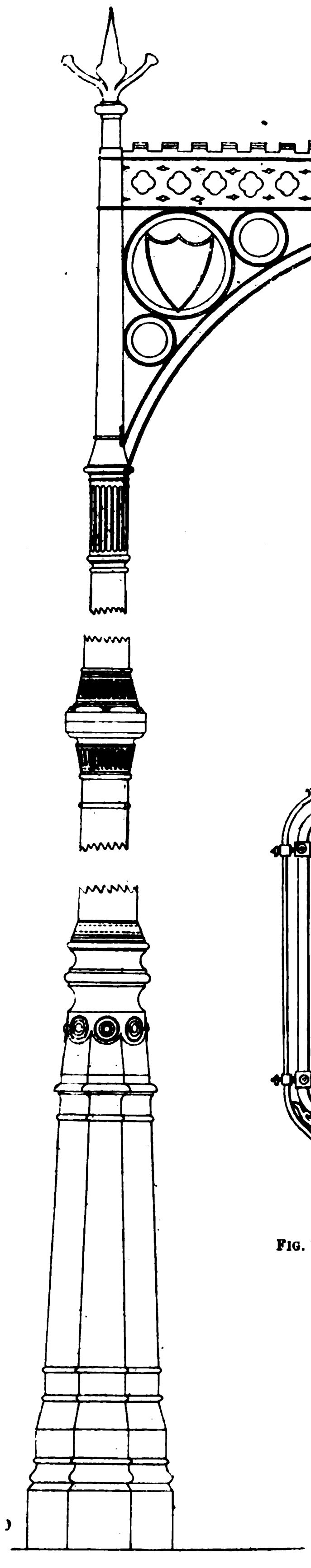

FIG. 12.—Lamp-post used at Chester.

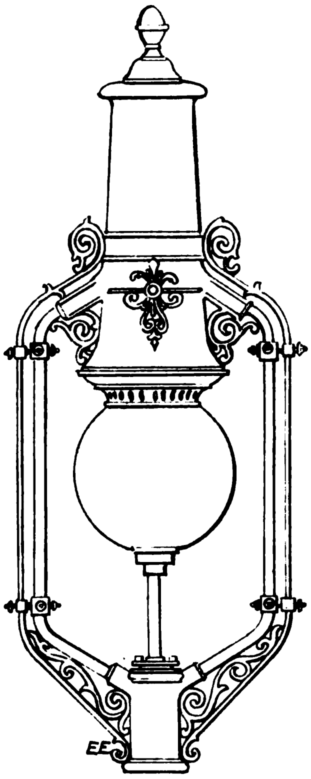

FIG. 13.—Type of Lamp-Carrier used on Gates of Town.

high, of Gothic design (Fig. 12), and in some cases on brackets attached to the buildings. The city gates are also to be surmounted with arc lamps, as shown in Fig. 13, in lieu of the existing gas lamps. The arc standards, together with the brackets, have been supplied by Messrs. Lucy and Co., of Oxford. It may be mentioned that they are of precisely similar design to those erected at Oxford. The arc lamps were supplied by Messrs. Johnson and Phillips, of Old Charlton, and are of their single-carbon 16-18 hour focussing type; they are fitted with 18in. light opalescent globes and copper spinnings. The lamps are regulated for a current of 10 amperes, and are joined up four in series on the street mains of 210 volts, a steadying or line resistance being used. Each lamp is fitted with a special automatic cut-out, and is provided with a substitution resistance, this being automatically inserted instead of a lamp, if by any means the rods stick apart, or the lamp is not trimmed, thus keeping the current constant, and preventing the others being put out; a fuse is arranged for at each end of the line joining the four lamps to the mains. Of the arc lamps, 22 are suspended from ornamental cast-iron columns, as shown in Fig. 12, and two in Messrs. Johnson and Phillips's standard carriers, shown in Fig. 13, the rest from brackets. The lamps are attached to the posts by special weather protecting hoods, having a ball and socket joint, so the lamp will hang perpendicular, notwithstanding the lamp-post may be a little out of truth.

RAILWAY BLOCK SIGNALLING.

BY J. PIGG.

(Continued from page 658.)

In concluding these articles it may be useful to recapitulate some of the chief conditions which experience and the general trend of development indicate as necessary, and it may also be of some interest to see in what degree the most modern apparatus is calculated, if adopted generally, to secure immunity from errors of a similar character to those which are known to have been the direct cause of some of the more recent accidents. It is only by the study of the combinations which make for or against the object aimed at that the knowledge usually denominated "practical" is obtained, and it is commonly acknowledged that the experience acquired from failure is most completely assimilated.

In a former article the chief causes contributing to accident were referred to. They may here be briefly summarised as follows: (1) acceptance of a train into a section which is already occupied; (2) sending a train into a section already occupied; (3) failure to notice the positions of the fixed mechanical signals. These deviations from the rules under which block working is carried on, have all at one time or another been the first cause of accident.

The three causes enumerated cover the possibility of error on the part of the three responsible persons engaged in the working of any train through a block section worked under absolute rules—viz.: (1) the signalman at the receiving end; (2) the signalman at the sending end; (3) the driver of the train passing into or out of the section. Of these three persons the first is usually considered as holding the most responsible position, since it is he who, under the ordinary working conditions, accepts or declines to allow trains to enter the section at the opposite end according to the condition of the line at the time. There is no doubt that when working strictly to regulations, the signalman at the receiving end is in a position of great responsibility, since, before accepting any train, he must assure himself that the *whole* of the preceding train has cleared the section, and that no obstruction exists, at his own station, which involves possible impediment to the approaching train throughout the *whole* length of the section it has entered, or is about to enter. A failure in observing this most elementary rule of block working led to a most disastrous accident on one of the leading railways about four years ago, and resulted in considerable loss of life under most lamentable conditions, and in great destruction of property.

During the time that work is carried on in accordance with the rules of the service, the sending signalman's responsibilities are confined to the exhibition of the proper mechanical outdoor signals for the information of the driver

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of any train which may approach, and generally acting in accordance with instructions received from the other end of the section. If, however, any deviation from the usual method of working occurs, either from negligence or inadvertence, it is just as likely to originate at the sending end as at the receiving end, and the results may be equally disastrous. There is no lack of instances where trains have been sent forward under the impression that the indication of the block instrument refers to that train, and the lowering of the signal at the proper time has been neglected. In other instances trains have been sent forward without any of the usual block signals being exchanged, and the signalman at the receiving end has had no intimation of the train until it came under his personal observation.

In so far as the *acceptance* of a second train into an absolute block section is concerned, apparatus of a similar nature to that shown by Fig. 50, Saxby and Farmer's (Figs. 55-60), or Sykes's (Figs. 67-71), in which the receiving instrument is locked to "Train on line" until the train signalled has passed a certain point, or one of a number of points at relief sidings or junctions, would appear sufficient. To be consistent, however, the arrangements should be completely automatic, and this, of course, involves the use of releasing treadles at each of the points at which a train may clear the section, and other means of cancellation than exist at present.

In so far as the *sending* of a second train into a section is concerned, such arrangements as are shown by Fig. 54 (Winter's), Figs. 63-65, (Saxby and Farmer's), or Fig. 74 (Sykes's), in which the signal controlling the advance section is locked until the "Train on line" or "Line clear" signal is accepted, and is automatically replaced to "danger" by the passage of the train into the section, are a great advance on the usual method of working, and should be sufficient to prevent such errors. These methods have the further advantage of not interfering with the usual method of working traffic or requiring the line to be cleared for a greater time than ordinary for an approaching train. This, of course, is a matter of considerable importance in the working of busy junctions.

In cases of non-automatic working, a point of some importance arises on further consideration of the two probable causes of error just referred to. In one case, the *acceptance* of a second train may be made under the impression that it has been forgotten to clear the line for the last train. On the other hand, as has been shown, a train may be sent into a section under a similar misapprehension. In neither case does the ordinary form of instrument afford any indication of the deviation from the regular methods of working, and any attempt to avert the consequences arising must depend upon the signalman remembering the conditions actually existing, and, recognising his error, taking such steps as are possible under the circumstances. Certainly some such intimation might be of the greatest possible utility to the signalman at the receiving end of the section; and it is quite conceivable that, under certain circumstances, prompt action on the part of the receiving signalman, as a consequence of an automatic indication of the presence of two trains in the section, might enable him to avert the consequences of the error by allowing the first train to draw within the protection of one of the stop signals. Such apparatus need be of the simplest possible construction, but, owing to its casual use, would require to be carefully maintained in working order.

If the third contributory cause of error—failure to notice the position of the fixed mechanical signals—is considered, it will be observed that there is not anything like the number of devices in use, or suggested, to protect the driver from possibility of error. With some exceptions the driver is the only person of the three concerned who has, practically, been left to depend upon himself. Whilst this is the case neither of the signalmen are in such a position of responsibility as the driver. Errors on the part of either of the signalmen may be minimised and accident averted by vigilance and promptitude on the part of the driver, and have been on many occasions. If, however, the driver errs and runs past the signals, the signalmen have no control over his actions whatever, and are powerless to avert the consequences. It cannot be too strongly insisted upon that block signalling is only a means to an end, and that end is the exhibition of the proper signals for the guidance of the drivers of trains. If the necessity for automatic control of the means of signalling to the driver is felt, and the general line of progress is sufficient to prove this, how much more important is it that special means should be provided to ensure that the person for whose guidance the whole system of signalling is devised, is really made aware of the conditions under which he is running at any and every point where signals are exhibited.

A big smash on one of the leading lines a few years ago was directly traceable to failure on the part of the drivers of the train to observe the positions of the mechanical signals at the entrance to the section in which the collision occurred owing to the prevalence of fog. One of the two drivers of the train which ran past the signals paid for the error with his life, and the other with the loss of a limb. It is true, of course, that railway companies have elaborated arrangements for replacing the usual visual signal by aural equivalents in the event of a fog, or other similar cause, preventing the former from being available. For the period of the introduction of fog-signalling, it was no doubt eminently suitable, but for the present period it leaves something to be desired. In the first place, the indication to the driver that the line is clear, and signals, which he cannot see, are off for his advance, is of a negative character only. The absence of an explosion, due to the engine passing over one or more fog signals, is taken as an indication that the line is clear to proceed. Under this condition the driver has no real assurance that fog-signalling has been commenced.

Again, the fog signals have, in the ordinary form of working, to be placed in position by men stationed at the signals, and these men must take the position of the arm as a guide to their own actions in placing the fog signals to be exploded, or removing them, according as the signal arm is "on" or "off." The control of the section of line protected by the signal is dual, and therefore, whilst there *may* be two possible checks against error, there are undoubtedly two points at which error may arise. Further, the calling out of the fogmen for their special work depends under the present system, in many instances, upon the signalman, and he must exercise his judgment upon the necessity, or otherwise, for calling out these men as occasion may require. Some time may elapse between the decision to commence fogging and the actual commencement, more especially during the night. During this interval the necessity for the fogmen may increase, or it may cease altogether. In the first case the signalman may think he has delayed calling out the men too long, and in the other case he would think his action was premature. In either case his position is not a comfortable one.

Many attempts have been made to provide automatic, or semi-automatic, means to warn the driver of the positions of signals he is approaching or passing, under conditions which prevent their being seen; and railway companies are by no means backward in giving a trial to apparatus which possesses any of the elements necessary to success. Some forms of apparatus for this purpose are adaptations of the ordinary fog signal to use, at any time, by the aid of mechanical means, by the signalman working the signal. Usually a number of fog signals are kept in a special case near the signal, and the signalman, by the use of a special lever in the cabin, communicating with the box by a wire, is able to place a fog signal near the rail, on a specially prepared base, for explosion by the depression of a rod over which the train passes. The ability to commence using the fog signal at any time is a great advantage.

Unless, however, the apparatus is duplicated, only one fog signal can be put in position at once, and in the event of its not being exploded, from any cause, the results may be serious. Moreover, the adjustment of the fog signal in position for explosion is somewhat fine for operation at such a distance as "distant" signals are usually placed, by the aid of a wire which is subject to alterations of length with varying temperatures.

(To be concluded.)

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INSTITUTION OF ELECTRICAL ENGINEERS, Dec. 10.

Dr. JOHN HOPKINSON (president) in the chair.

This was the annual general meeting. There was no paper down for reading and no ballot for new members.

After the formal business, the **Chairman** asked Mr. Campbell Swinton to be one of the scrutineers of the ballot papers for the election of the officers and Council.

Mr. Swinton: Is there anything to scrutinise? [As no additional nominations had been made, the house list, as given in our issue of November 20, must necessarily be elected.]

The **Chairman**: We shall have to go through the form.

The **Secretary** (Mr. Webb): There can hardly be an election without a return of the ballot papers. There have, as a matter of fact, been a considerable number of papers sent in.

Mr. Fairfax was nominated as the other scrutineer, and later on the formal report of the election was made.

The following is the report of the Council:

Elections.—The total number of additions to the register during the year has been 246, comprising eight foreign members, 14 members, 128 associates, and 96 students; and 58 candidates have been approved for election next month. Twenty-two associates have been transferred to the class of members, and 72 students to the class of associates.

Deaths and Resignations.—The losses which the Institution have sustained by death, although greater than last year, are not above the average. As follows: three foreign members—L. Beckwith, W. C. A. Staring, Dr. A. Stoletow; five members—A. Bell, F. S. Harwood, J. Thewlis Johnson, H. J. Vose, and Gordon Wigan; 15 associates—E. W. Adamson, E. Burn, A. Calder, G. F. Clements, A. T. Durrant, W. Eccles, H. L Harris, H. C. Hodges, J. A. Kingdon, A. Langman, E J. Lecoat, H. C. Oates, C. H. Phillips, J. R. Pickering, and C. M. Stobart; one student—A H. Gossage. Mr. Staring, a past director-in-chief of the Netherlands Telegraphs was one of the original members of the Institution. Mr. A. Bell, who was for a long period connected with the Postal Telegraph Department, had been a member for 20 years; Mr J. Thewlis-Johnson was one of the original members; and Mr. Gordon Wigan had been a member for 23 years. Four foreign members, nine members, 21 associates, and seven students have resigned during the year.

Papers.—Besides the valuable inaugural address of the President, the following papers have been read during the year: February 27, "High-Voltage Lamps and their Influence on Central-Station Practice," G. L. Addenbrooke (member); March 26, "Telephone Exchanges and their Working," Dane Sinclair (member); April 30, "On Railway Telegraphs, with Special Reference to Recent Improvements," W. Langdon (member); May 14, "Experimental Tests on the Influence of the Shape of the Applied Potential Difference Wave on the Iron Losses of Transformers" Stanley Beeton, C. Percy Taylor (students), and J. M. Barr; May 28, "The Utilisation of Water Power, especially with a Small Fall, with some Examples of Plants for Generating Electrical Energy," A. Steiger; November 12, "Telephone Trunk-Line System in Great Britain," J. Gavey (member). The list is smaller than usual, owing to the circumstance of the discussion of two papers read in November of last year having occupied two of this year's meetings.

Annual Premiums.—In respect of the papers read during the session 1895 96 by others than members of their own body, the Council regret that only one is of that character and possesses sufficient merit to entitle the authors to a premium—viz., "Experimental Tests, etc," by Messrs. Stanley Beeton and C. P. Taylor (students), and J. Barr. To the authors of this paper they award the Institution premium, and having regard to the fact of the authors being three in number, they intend to increase the premium from £10 to £15. Of the papers read at the students' meetings the majority have been of considerable merit, and the Council have decided to present on this occasion two premiums of £3. 3s. each. They award one of these to Messrs. Ray and V. Watlington for their paper on "Underground Conductors," and the other to Mr. E. B. Wedmore for his paper on "A Simple Method of Analysing Harmonic Curves." Honorary mention is made of the following: "Post Office Form of Wheatstone Bridge" by G. Lemmens; "Electricity Supply Meters," by G. W. D. Ricks.

Salomons Scholarship.—The Council have awarded a scholarship of £50 to Mr. E. W. Marchent, a student of the Central Technical College.

Students' Class.—The Council have observed with satisfaction not only the continued improvement in the character of the papers read at the students' meetings, but also an increased activity on the part of the Students' Committee in other directions. Your secretary was able to arrange for visits by parties of the students to the following works and stations during the session—viz, Messrs. Willans and Robinson's works, Thames Ditton; St. Pancras electric light stations; Messrs. Siemens Bros.' works at Woolwich; Metropolitan Electric Supply Company's station; the City of London electric supply station, Bankside; the London Electric Supply Company's station at Deptford; the General Electric Company's "Robertson Lamp Factory," Brook Green; the Board of Trade laboratory (by kind permission of Major Cardew). To the above-named firms and the engineers of the several companies the Council desire to acknowledge their appreciation of the kind facilities thus afforded to the students of the Institution. In September last a visit by some of the students to Switzerland was organised by permission of the Council, and your secretary was enabled, chiefly through the good offices of Dr. du Riche Preller (member) and Mr. A. Steiger, to obtain for the party special facilities for inspecting many of the most important electrical and engineering works in that country, their reception being of the kindest character.

Fire Risk (Wiring Rules).—The final revision of these rules has been purposely delayed in consequence of the sanctioning by the Board of Trade of the use of higher voltages, rendering necessary considerable further alterations in and additions to the rules. The Council have made a grant of money from the funds of the Institution for the purpose of enabling the committee to carry out tests of switches, fuses, and other appliances as now supplied by manufacturers, in order to ascertain how far these are suitable for the increased pressures. A committee was appointed by the Council on May 28 to consider the Council's expenditure in the direct advancement of the electrical industry, and whether, having regard to the annual surplus, the time has not arrived for greater expenditure in that direction, and report.

Annual Dinner.—The annual dinner, which was this year held at the Criterion Restaurant on November 25, was largely attended, the chief guest being the Duke of Norfolk, Postmaster-General.

Annual Conversazione.—The conversazione was this year again held in the galleries of the Royal Institute of Painters in Water Colours, and was very numerously attended.

Building Fund.—In accordance with a resolution passed at the meeting of members and associates on July 6 last, certain stock, representing at the price of that day the sum of £3,500, have been transferred to the building fund account, and the interest accruing from the same has been and will be in future credited to the same account, and will be invested from time to time. It is a striking and satisfactory proof of the sound judgment exercised by your hon. treasurers (the late Mr. E. Graves and Sir D. Salomons) in making the Institution's investments, that the increase in value of the stock so transferred to the building fund between the date of their purchase and that of their transfer was no less than £221. 1s. 5d., which sum figures in the balance-sheet as profit added to the general fund.

Annual Accounts and Financial Position.—In accordance with the resolution passed at the ordinary general meeting of March 12 last, the statement of accounts and balance-sheet for the year ending Detember 31, 1895, as then presented, were re-cast, and were in their new form adopted at the special general meeting of members and associates held on July 6. Among the alterations made in the articles of association by the special resolution previously alluded to was one enacting that the financial year should thenceforth be taken to end on September 30 in each year, and that the annual accounts should in future be made up to that date and laid before the annual general meeting next following. Accordingly, the statement and balance-sheet to be presented this evening only covers the nine months comprised between January 1 and September 30 last. The accountants have considered it desirable to make some further slight modifications in the form of these accounts, but they are framed substantially on the same basis as those adopted last July. It will be seen that the receipts exceed the expenditure during this period of nine months by the amount of £887. 19s. 6d., and this is without debiting the receipts with anything on account of outstanding subscriptions (the estimated realisable amount of which on September 30 was £532), as had this been done, the accounts would have shown 12 months' income as against only nine months' expenditure, with the result that the balance then shown would have been misleading. When the next year's accounts are made up this difficulty, of course, will not arise. The sum of £801. 3s. has been invested during the year on account of general investment fund, and £75 on account of life compositions. As announced by the President at the ordinary general meeting of November 12, Sir D. Salomons found it necessary, in consequence of the many calls upon his time, to decline nomination this year for re-election as hon. treasurer. The Council greatly regret that such should be the case, as although under the revised articles of association Sir D. Salomons could no longer have remained a vice-president, they had hoped by his re-election as hon. treasurer to continue to have the benefit of his advice, which has hitherto proved of so much value.

Amendments in the Articles of Association.—With a desire to meet as far as was desirable in the general interests of the Institution various suggestions which had reached them, your Council appointed a special committee to consider in what direction the articles of association might be amended with advantage, the result being that a series of amendments were submitted by the Council to a general meeting of members only on June 15 last, and adopted by a unanimous resolution, which was duly confirmed, and thus made a "special resolution" under the Companies' Acts on July 6. The Council earnestly trust that these amendments will work satisfactorily, and will tend to strengthen that feeling of confidence which should subsist between the general body of members and their elected representatives.

The Library: Secretary's Report.—I beg to report that the accessions to the library during the year number 53; of these five were purchased, the remainder having been kindly presented either by the authors or publishers. The specifications of all electrical patents continue to be supplied to the Institution by the kindness of H.M. Commissioners of Patents. The number of patents applied for this year up to November 25 was 26 425, of which 1,314, or 4·97 per cent., were electric. The corresponding numbers last year were 22,422 and 1,367, or 6·09 per cent. The periodicals or printed *Proceedings* of other societies received regularly are, with some few additions, the same as last year. The number of visitors to the library to the end of November has been 654, of whom 67 were non-members. The corresponding numbers last year were 743 and 116 respectively. F. H. WEBB, Secretary.

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The **Chairman** formally moved the adoption of the report, and **Sir Henry Mance** seconded it. An informal discussion then followed on a multitude of subjects.

Mr. Fairfax put a question as to where the new articles of association were obtainable, and the **Secretary** said they were circulated at the time of the change (last summer), and subsequently were printed in the *Journal* of July and August.

Mr. A. A. Campbell Swinton suggested that at the annual conversazione there should be scientific instruments exhibited and experiments shown. To do that would be only taking a leaf out of the proceedings of the Royal Society. At present there were three attractions at their conversazione—the ladies, the refreshments, and the music. What he proposed was something more scientific, as not everyone was able to attend the conversazione of the Royal Society.

A suggestion was also made by **Mr. Groves** that the sessional year, as well as the financial year, should begin on September 30.

Mr. Erskine thought the conversazione might be held in a better place, where they would have more room and better air.

Mr. E. W. Parsons said that the Queen's Hall would be a suitable place.

Mr. C. B. Clay suggested that the Council should specially invite papers from gentlemen who were exceptionally qualified to give them on any particular subjects.

Mr. C. Bright suggested the Imperial Institute as a good place for the conversazione. There were a great number of vacant rooms there.

Major Flood Page, in reference to the Wiring Rules Committee, asked whether the fuses and other articles to be sent in to the committee by the makers would be unmarked and not identifiable as the work of any particular firm. If that was not so, he thought he could say some makers would find themselves unable to co-operate in the matter. They might not care to submit to a scientific opinion on what was really a commercial product.

The **Chairman** said Mr. Crompton, as chairman of the committee in question, would reply.

Mr. R. E. B. Crompton said the committee went on the principle that the manufacturers knew their own business better than anyone else. They had to keep in mind the requirements of the higher voltage now permitted by the Board of Trade, and in the revised rules which would be shortly issued certain figures relating to lengths and other dimensions would have to be inserted. The committee could insert suitable figures from their own knowledge, but they considered it would be presumptuous to do so without getting at what was the latest practice in the matter. The idea was that the manufacturer should send in what he made, and the articles should be roughly tested to see that they fulfilled their purpose, and then what were found the minimum distances filled into their rules. The articles when done with would be returned. The object was to make the rules as little oppressive as possible. There was no doubt that in that way the committee would obtain very valuable results, and ultimately embody them in a report; but before the name of any maker was published his permission would be obtained. The immediate object of the committee was to issue the regulations as soon as possible.

Major Flood Page said that there would be strong objection to something like a trade advertisement coming from a scientific committee. He again suggested that the samples should have no makers' names on them.

Mr. Crompton said it was the wish of the committee to fall in with the general desire on the matter, but on some articles it would be difficult to obliterate the names or marks, when, for example, they were of porcelain.

Mr. R. S. Erskine urged that the new regulations were wanted by the supply companies as speedily as possible. Consulting engineers did not know at present what to specify nor contractors what they must look to provide. It was mainly a matter of length of breaks and that sort of thing, and hardly touched matters really material to the rival interests of the trade.

Mr J. S. Raworth congratulated the Council on the manner in which they had met the wishes of some of the members of the Institution—wishes perhaps which had not been expressed at the time so well and clearly as could have been wished. Although there was only a small attendance that evening, he thought that the experiment of having no paper on the evening of the annual general meeting had proved a success.

The **Chairman** said that with regard to the annual soirée the exhibition of scientific instruments and experiments would be obviously impossible unless they held their soirée in a new place. In his previous presidency, in the endeavour to find a better place, it had come to pass that the soirée had to be put off until the autumn instead of being held in the summer. That had made him naturally reluctant to attempt an innovation of this kind during his present presidency. To alter the time at which the new council is elected to the time the sessional meetings begin would necessitate an alteration of the articles of association. The question of obtaining special papers from specially qualified men had been already under the consideration of the Editing Committee, and would be still further considered by them. In reference to the alterations made in the articles of association and the constitution and election of the Council, it had really been their desire not only that the Institution should be worked in the best way, but that it should be worked in the way desired by its members.

The resolution for the report was then put and carried unanimously, and a second resolution for the accounts having been formally proposed by the **Chairman**,

Major Flood Page seconded the resolution, and called attention to the fact that the *Journal* cost £599, so that when the postage was added it appeared that 30 per cent. of their annual subscriptions went for the cost of the *Journal* [postage of the *Journal* and notices of meetings was £239]. In an institution to which he belonged—the United Services—with more than double the number of members that the Electrical Engineers had, the result of a circular sent round was to show that a large number of the members did not care to receive the *Journal*. In that case there was no other means of getting the papers which were read, but they (the Electrical Engineers) got them at once in the columns of the technical Press. He thought if a similar circular were sent out by the Institution it might result in the saving of £100 or £200 a year of the money now spent in printing copies of the *Journal*.

The **Chairman** said that Major Flood Page's suggestion should receive the consideration of the Finance Committee.

The resolution for the accounts was then put and carried unanimously.

Prof. Silvanus Thompson then moved a vote of thanks to the Institution of Civil Engineers for giving them the benefit of holding their meetings in that building. The Civil Engineers not only gave them their large and commodious rooms, but also supplied them free with the electric energy for lighting and with the services of their attendants. In fact, he believed the Institution of Electrical Engineers was at the cost of nothing except the refreshments supplied after the meetings, so that their debt to the Civil Engineers was a very practical one. He would like to embody in the vote of thanks a clause congratulating the Civil Engineers "upon the splendour and magnificence of their new building."

Mr. Sydney Morse seconded this, and the vote of thanks, with the addition of the congratulatory clause, was then carried.

Mr. Frank Bailey moved a vote of thanks to the foreign honorary treasurers and secretaries.

Mr. Dane Sinclair seconded this.

Major Flood Page, as germane to the subject, suggested the desirability of endeavouring to encourage the formation of affiliated institution in the Colonies, specially mentioning the Australian Colonies and the Cape of Good Hope. They might start with quite a small number of members at first, but in this way their Institution would become the parent and chief of a network of institutions and be a rallying point for the profession throughout the whole of the British Empire.

Mr. E. Manville also suggested that it would be advantageous to members of the Institution practising abroad, and particularly in Argentina and other South American States, if a certificate or diploma of membership were given. In the more out-of-the-way parts of the world a mere exhibition of the list of members was not always accepted as sufficient evidence as to a man's professional standing in the way that a certificate would be. In Argentina the Government were proposing to introduce a rigid examination which would have to be passed by those wishing to practise as electrical engineers. Immunity would, however, be given to members of Institution of Electrical Engineers.

The resolution was then put and carried.

Mr. R. E. B. Crompton rose to move a vote of regret at the retirement through ill-health of Mr. John Aylmer, the local secretary and honorary treasurer of the Institution in France. Mr. Crompton added an expression of the personal regret with which he received the news of Mr. Aylmer's ill-health, and spoke in very high terms of the courtesy and kindness he had displayed to the members, and the attention he had always given to the interests of the society.

Mr. Edmunds seconded this, and, like Mr. Crompton, referred to the work done by Mr. Aylmer on the occasion of the Paris exhibitions.

The **Secretary** (Mr. Webb) said that he might add a few words, as the services rendered by a local secretary came more prominently before him than they could do before the members of the Institution. No local secretary could be more ready to do anything for the Institution than Mr. Aylmer, and he might add that even quite recently—he might say at the last moment—Mr. Aylmer, in spite of his ill-health, had taken special trouble to enable him (the secretary) to obtain numbers of a journal that he had been unable to secure through any other means.

The resolution was then carried.

The **Chairman** moved that the best thanks of the Institution be given to Sir David Salomons for his past services on the occasion of his retirement from the office of honorary treasurer.

Mr. C. Bright seconded this, and the resolution was carried.

Sir Henry Mance proposed, and **Mr. Raworth** seconded, a vote of thanks to the honorary auditors (Messrs. Danvers and Stroh), and **Mr. Sinclair** moved, and **Mr. Raworth** seconded, a similar vote to the honorary solicitors.

Mr. Raworth proposed a vote of thanks to the President (Dr. Hopkinson), specially mentioning the trouble he had taken in reference to the alteration of the articles of association.

Mr. Page seconded this, and congratulated the Council on the ballot list they had prepared. He was pleased to see the two new members of Council from Manchester present that evening, and looked forward to a large increase in the number of members of the Institution and a third time of presidency for Dr. Hopkinson.

The **Chairman** briefly acknowledged this, and the proceedings ended.

The next meeting is on January 14, when the new president (Sir Henry Mance) will deliver the presidential address.

Ashton.—The Town Council have decided to erect 60 arc lamps in certain streets. Mr. Clirehugh's report recommended the erection of 150 lamps. The draft agreement between the Corporation and the British Electric Traction (Pioneer) Company relative to the supply of power to the tramway company has been submitted to the solicitor to the tramway company for approval.

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THE BRISTOL TRAMWAYS.

The following is the report of Mr. H. F. Parshall on the above subject, together with opinions by Dr. John Hopkinson and Lord Kelvin :

Gentlemen,—I have considered the report of Mr. W. H. Preece to the town clerk of Bristol on the subject of electric traction on tramways. It would be difficult to make an intelligible answer to Mr. Preece's report by taking it up from point to point. However, the fundamental ideas of the report can be sub-divided so that an answer can be easily followed.

I take it that what Mr. Preece has attempted to demonstrate is that (1) the electrical trolley system is the most efficient and useful system ; (2) that the supply of electricity from the Lighting Committee's plant at Bristol can be done more cheaply than by the tramway's company with such plant as they may construct. The first point may be inferred from Mr. Preece's report. On the second, however, there can be no misunderstanding as to Mr. Preece's recommendation.

The points that I would bring to your attention with respect to the first proposition—that is, with respect to the fitness of the trolley system for Bristol—are as follows : that both in Europe and the United States it is an accepted fact that the trolley system is simplest, most economical, and, if well constructed, is not æsthetically objectionable in streets ; that in case of such narrow streets as Lawrence-hill and West-street, which have been successfully operated by the trolley system for more than a year, the trolley system has not been found objectionable, nor has any necessity for a conduit suggested itself, and I know of no other streets in Bristol which it is proposed to equip that are so congested and generally unfavourable.

With regard to the examples of conduit system instanced in Mr. Preece's report, that of Budapest is exceptional, and for reasons of which you are well aware, open to such objections as render the system unsuitable to this country. The one at Blackpool is too small to be of any assistance in judging what may or may not be found useful in Bristol. As to Chicago, Mr. Preece is under a misapprehension, as there is no conduit system, and the trolley has been sanctioned to supersede the cable system. In Washington the conduit system is in use, but the conditions at Washington differ widely from those at Bristol, and the system in general has been installed for a short time only. It remains to be demonstrated whether or not it will stand the conditions brought to bear upon it by an American winter or by such conditions of moisture and street traffic as obtain in Bristol. In New York the conduit system is not considered sufficiently practicable to admit of any further extension. The engineers who installed the first line have advised their directors that a further extension of the present system is not warranted by the facts gleaned from the operation of the present conduit system. It seems hardly necessary for me to say that I quite concur with the opinion and conclusion of Mr. Preece that the conduit system is not economically practical in Bristol, and that we must consider things as they are.

Taking it therefore as an accepted fact that the trolley system is the one best adapted for the operation of tramways, the remaining point to be considered is whether or not the electricity for such a system can be more economically supplied from a lighting station such as now exists at Bristol or from a station specially designed to meet your requirements and specially managed by your own staff. I shall first consider the experience gained in the United States, where both electric lighting and electric traction have been carried on to a very large extent, and where both have reached a high state of perfection. Amongst the most representative cities are Boston, Chicago, and Washington, in which both electric lighting and electric traction may be said to have attained alike prominence and perfection. If you were to ask a manager of either the traction company or the lighting company in these cities whether or not he considered there would be any advantage in consolidating the electric supply for the lighting and tramways systems, you would receive a direct answer that there would be no possible advantage and that there would probably be some disadvantages. These men, having had large experience and observation, have seen that the nature of supply is absolutely different. In the case of electric lighting, the supply of energy from moment to moment is practically constant, and the desired condition is constant pressure, so that the lamps may be kept at a uniform light. In the case of electric traction, the supply of electricity from moment to moment varies greatly. Take your own St. George's station as an example. The power output at one moment amounts to not more than one-fifth the output of the working machinery. A moment afterwards the whole capacity of the working machinery is utilised. To properly supply electricity for a traction system, it requires machinery of much the same nature as that required in a rolling-mill, in which the load is either all on or all off and from moment to moment. In the cities above referred to the lighting and traction generating plants are entirely separate and distinct, as indeed in all other cities in the United States with which I am acquainted ; and, as you know, my experience in the States has been very general, inasmuch as much of the machinery in use there has been built from my designs. It is agreed by all authorities there that owing to the different conditions of supply there would be no economy, and probably a direct disadvantage, in supplying both systems from the same plant.

The next statement by Mr. Preece that I desire to bring to your attention is that the reduction of the total cost per unit as the output increases is well shown in the case of Manchester. I admit that this is true in the case of Manchester. The fact remains, however, that all the electricity is supplied for the same purpose, but if the electricity were supplied for two such widely different purposes as electric traction and electric lighting, the opposite would probably be found to be the case. If the same machinery were used for both purposes, either the tramway or the lighting would suffer. It is a recognised fact that incandescent lamps cannot be made to burn steadily in a system where the loads rapidly fluctuate, as in a tramway system. Taking up specifically the cases mention by Mr. Preece where both electric lighting and electric traction plants are supplied from the same station, we will consider that of Hamburg. The machinery was specially designed with reference to a combined lighting and tramways system, and was primarily designed to suit the requirements of tramway system, the lighting system being considered of minor importance. The only advantage gained is that the machines can be interchanged in case of failure ; in case one of the tramway machines fails, a certain amount of lighting apparatus can be utilised. None of the machines are, however, used for both purposes at the same time. You will see that such an arrangement as this offers no precedent for Bristol, since the lighting machinery now installed could not in any case be used in place of the machines required for the electric traction work. The two plants would have to be separate and distinct, as is admitted by Mr. Preece. In each plant there would have to be the same margin for over-loads, short circuits, and emergencies ; since in the case of emergencies neither plant could be utilised to assist the other. Even in the case of the Hamburg arrangement it has not been demonstrated that there is any increased economy resulting from the supply of electrical energy for both lighting and traction purposes from under the same roof ; and, as illustrating the feeling of the tramway company with reference to the use of a plant not controlled by themselves, I may refer to the company's last annual report stating that "we could have transported even more people if the Hamburg electricity works would have kept pace with us in their progress." I would further point out that the differences that exist between England and Germany in the price of labour make comparisons of cost altogether misleading. The average wage of a motorman in such a system as that at Hamburg is about 18s. per week, whereas your motormen on the St. George line receive 30s. a week, and, as you know, the item of labour in connection with tramway work is the principal one to be considered. With respect to the cases of Dresden, Geneva, Havre, and Rome, I have already furnished you with information which you have published, showing their total inapplicability to Bristol. An additional feature which occurs to me with regard to Rome is that the storage batteries for bridging over the interval in the evening, although only for 12 cars, involve a weight of lead amounting to 100 tons, and such an arrangement for Bristol would necessitate the provision by the Lighting Committee of 1,500 tons of lead in batteries !

It cannot be too strongly impressed that there does not exist at the present time such an installation as Mr. Preece suggests as practicable for Bristol. His load diagrams seems to show that the maximum loads overlap, though as to this uniformly occurring I cannot agree with him, since the maximum load of the tramway company may or may not occur at the time suggested by Mr. Preece. The maximum loads occur on certain days—that is, holidays and Saturdays—and not at certain hours of any particular day. The two maximum loads may, however, occasionally happen at the same time. In tramway experience it has been found most economical to provide for these maxima by a proper margin in the generating machinery, and storage batteries in large systems are not considered economical or practicable. In some lighting installations in Germany, storage batteries have been found practicable and economical for lighting purposes. If, as Mr. Preece suggests, the modern accumulator eliminates the possibility of a breakdown or renders one independent of the machinery at a breakdown, why have these not been installed at Bristol so that in case of a breakdown of the alternators these accumulators could take up the load ? In the system as now installed, this provision has not been made, having regard either to economy or emergency, and for the very reason that the installation at Bristol is not supplied with such machinery as permits of economical storage nor of the supply of energy for an electric tramways system. I would point out to you that a system of storage in connection with the present lighting machinery would be both inefficient and expensive. Synchronous motors of the same capacity and cost as the alternators now used, as well as dynamos of approximately the same cost, would be required in connection with storage batteries. The efficiency of such a system would then be only about 70 per cent., as against 100 per cent. when the electricity is delivered direct to the consumer's circuits, as you are proposing to do in connection with your tramway work.

There are other points to which I would draw your attention. First, with respect to Mr. Preece's load diagrams. The amount of power he proposes is altogether insufficient for the number of cars upon which he bases his calculations. Mr. Preece states your car stock at 100 ; as a fact it is 125. He estimates it will be increased to 150, which I accept in my estimates of power required. Mr. Preece proceeds to state the daily average run per car at 70 miles, whereas from your own experience at St. George you know that not less than 100 miles is the regular practice. Again, for some inexplicable reason, Mr. Preece takes 300 days per annum, instead of the 365 known to tramway managers, the result being that his mileage for one car amounts to 21,000 per annum as against 36,500, which is the fact—an error on Mr. Preece's part of no less than 75 per cent., which multiplied over the 150 cars gives a similar mistake in the quantity of electricity to be consumed, so that instead of the 3,150,000 units per annum of Mr. Preece, you would require 5,475,000 units, even assuming for the moment that one unit per car mile would be adequate, having regard to the difficult gradients

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in Bristol. You will appreciate the magnitude of this miscalculation when I remind you that the error represents four times the total quantity generated last year by the Bristol Corporation electricity department. Equally so with reference to the generating plant estimated by Mr. Preece as sufficient for the tramway purposes, you are aware that I have already advised you that it would be necessary to instal plant of approximately twice that capacity. Further, Mr. Preece himself, while recommending a distinct electrical plant, claims that the staff would be common. Considering, however, the differences in the machinery and the different conditions of supply, a separate staff would be required for each branch. I have already pointed out the inefficiency of any storage system as applicable to the Bristol alternators, and it follows, therefore, that there would also require to be provided a full complement of engines, boilers, etc., for each business. Where, then, with duplicate machinery, duplicate staff and absolute lack of interchangeability can there result any economy?

I do not agree with Mr. Preece's statement that three (or perhaps four) central stations would be found necessary in Bristol, inasmuch as one central station properly situated will be entirely sufficient for your purposes. With regard to Mr. Preece's criticism of the location of your St. George station, I may point out that the district served is an outlying one, and the station is favourably placed to enable you to comply with the requirements of the Board of Trade restricting the drop in the earth return to seven volts. The location of that station is also advantageous in view of your contemplated operation of the Old Market and Staple Hill line from that source.

Considering finally Mr. Preece's closing statement, he has not demonstrated that the cost of production per unit will be reduced by the arrangement proposed by the Lighting Committee. Considering the wide differences in the nature of supply of electricity for an electric traction and an electric lighting system, the combination of two such systems of supply would divert the attention of the electric lighting engineers from their legitimate field and render the supply of electricity to both consumers uncertain or unsatisfactory, since a special knowledge and a special staff are required for the proper carrying out of either branch of the work. As your engineer, I should strongly advise you not to hazard the success of the entire business of your company by undertaking to extend the system of electric traction in Bristol, if accompanied by a condition that you are not to be permitted to generate your own supply of electricity.

(Signed) Horace Field Parshall, M.I.C.E., M.I.E.E.
December, 22, 1896.

Opinion of Dr. John Hopkinson, F.R.S.

Gentlemen,—I have carefully considered Mr. W. H. Preece's report to the Bristol Corporation Electric Lighting Committee and Mr. Parshall's report to the directors of the Bristol Tramways Company, and I fully concur in Mr. Parshall's recommendation—viz., that you should not extend electric traction in Bristol unless you are permitted to generate your own supply of electricity. In my capacity as an adviser to municipal corporations I have given the question at issue some study, and have no hesitation in advising that in the particular circumstances at Bristol the Corporation cannot possibly supply the current to the tramway company as cheaply as the tramway company can generate it for themselves. The tramway company would be ill advised in entering upon such a dual arrangement as that suggested by the Lighting Committee's adviser, for I am convinced that such an arrangement would result in serious disadvantage to both parties.

December 5, 1896. (Signed) J. Hopkinson.

Opinion of Lord Kelvin, D.C.L.

I have read Mr. Preece's report to the Lighting Committee of the Bristol Corporation and Mr. Parshall's reply to the Bristol Tramways and Carriage Company. I agree with Mr. Parshall that the present Bristol plant is altogether unsuited for the supply, or for economically contributing to the supply of the tramways system. The supply of an electric tramway system in conjunction with a lighting system could not in my opinion be realised with good economy under the conditions obtaining at Bristol. The tramway company having already had more than a year's practical experience in the use of electric traction on a part of their lines are well qualified to judge of their needs for the whole; and considering all the circumstances, I am strongly of opinion that the Corporation of Bristol cannot do better than leave the tramway company free to arrange its own plans for generating, supplying, and using electricity for its traction.

December 5, 1896. (Signed) Kelvin.

LEGAL INTELLIGENCE.

THE HOPKINSON PATENT.

In the petition by Dr. John Hopkinson, F.R.S., and the Westinghouse Electric Company for the prolongation of letters patent granted in July, 1882, in respect to a method for distributing electricity, it will be remembered that, after arguments were heard before the Long Vacation, their Lordships intimated that they declined to grant the prayer of the petition, but would reserve their reasons for their report to her Majesty. These reasons were given on Wednesday by Lord Hobhouse in a court constituted by Lords Hobhouse, MacNaghten, and Davey, and Sir Richard Couch. For the subjoined report of their Lordships' judgment we are indebted to the *Times*.

Lord Hobhouse, in now delivering their Lordships' reasons, said: The petitioners in this case are Dr. John Hopkinson, the inventor and patentee, and the Westinghouse Electric Company, who are assignees of the patent. Before the case was opened, the Attorney-General drew the attention of their Lordships to some statements in the petition which, as he contended, disclose a grave objection to the extension prayed for. It appears that in 1889 the petitioning company was formed for the purpose of acquiring the beneficial interest in the patent, which was then vested in an American company under an agreement with Hopkinson; that since July 20, 1889, the petitioning company have worked the invention for their own benefit; and that in 1891 Hopkinson formally declared himself to be a trustee for them. It further appears that prior to 1889 Hopkinson made the trifling profit of £350 from this patent and from one taken out by him in Germany, but that subsequently to the agreements by which the company acquired the beneficial interest he has received the sum of £19,400 as the price of the English and German patents. The only substantial petitioners, therefore, are the company. Hopkinson has no interest, but it is not alleged that the sum of nearly £20,000 is less than an adequate remuneration to him. The Company state that their expenditure in acquiring the patents and in defending them against encroachment has largely exceeded their receipts, and they contend that they stand in the position of persons who take up and assist inventors in developing useful inventions, and that this merit has been recognised as entitling assignees of patents to a prolongation of the term. To support this contention Mr. Moulton referred to the judgment of this Board delivered by Lord Brougham in the year 1843 in the case of Morgan's Patent (1 Webst. Pat., Ca., 737). Lord Brougham there points out that a patentee is benefited by the chance of a sale, and therefore in his interest consideration has been given to the claims of assignees. That shows the reason why assignees have been allowed to come for prolongation, and it shows no more. When they do come, all the circumstances, including the inventor's remuneration, must be considered. In the particular case cited prolongation was refused. The claims of assignees were the subject of consideration in the case of Claridge's Patent, which was decided in the year 1851 (7 Moo., P. C., 394). The judgment of the Board was delivered by Sir J. Jervis. He pointed out that assignees, though their right to petition was recognised, were not to be treated with the same indulgence as patentees. In that case Claridge, the inventor, had received ample satisfaction. The company, his assignees, had entered into a commercial speculation, and their loss was not a ground for prolongation of the patent. The same subject was discussed more fully in 1863 in Norton's Patent (1 Moo., N. S., 339), when Lord Romilly delivered the judgment of this Board. He quotes the language of Lord Langdale in a previous petition by the Electric Telegraph Company. After saying that it would not be right to take into consideration the commercial affairs of the company, Lord Langdale continues thus: "They buy this patent right; they buy it for a commercial purpose, not at all with the view of encouraging the inventors or of rewarding the inventors, though when they are sinking their own capital in this particular mode they do incidentally give a profit to the inventors. It is not the same case as some cases which have arisen where the inventor, being himself struggling with difficulty for the want of capital, is obliged to obtain the assistance of persons who have capital, giving them a share of the profits, which may be done in a great variety of ways and under many different circumstances; but these parties, with a knowledge of the value of the invention and its capability of being reduced to practical use to any extent to which capital might be employed upon it, think fit to engage that capital in carrying on a trade by the use of this particular invention." Lord Romilly then adds (to this quotation from Lord Langdale): "The ground that the merits of the inventor ought to be properly rewarded in dealing with the merits of an invention which has proved useful and beneficial to the public does not exist in the case of an assignee, unless the assignee be a person who has assisted the patentee with funds to enable him to perfect and bring out his invention and thus enabled him to bring it into use, none of which grounds exist in the present case." The Act of 1883 has, by defining the word "patentee," confirmed the assignee's right to petition for prolongation, and it empowers her Majesty to grant it if this Board reports that "the patentee" has been inadequately remunerated. But their Lordships do not consider that by this definition the Legislature has placed assignees on the same favourable footing as inventors with regard to prolongation, or has altered the principles which guided this Board in the cases above cited. It cannot be seriously contended that an assignee, who may have purchased a patent at a late period of his life, can, if he has lost money, come here alleging that he is by statute a patentee who has been inadequately remunerated, and ask for a report to that effect. In the case of the Bower-Barff Patent (App. Ca., 1895, p. 657) the principles of the prior cases were applied by this Board. In that case, as in the case now before their Lordships, the original inventors had received substantial remuneration, and the assignees had suffered loss. In delivering the judgment of the Board, Lord Watson pointed out that the inventors had no practical interest in the question, and were in the same position as if they were dead, because they had no longer an interest to ask for a prolongation on their own account, seeing that they had been sufficiently remunerated at the expense of the public. Their Lordships consider that they would be departing both from authority and from sound principle if they were to hold that this company occupies the position of an inventor who has been inadequately remunerated. The company entered on a purely commercial speculation,

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which unluckily for them has up to the present time proved unremunerative. They did not assist to perfect or bring out the invention. They purchased it, or at least the beneficial interest, out and out, from a prior assignee of the inventor, who has in one way or another been well paid, and has now no claim or interest to ask for an extension. It is therefore impossible for their Lordships to make such a report as under Section 25 of the Act is the necessary condition of extension. The petitioners must pay the costs. There are as many as seven sets of opponents, and there ought not to be in this case more than one set of costs allowed. The matter stood over to give the parties an opportunity of agreeing as to an amount. It was intimated that in case of non-agreement their Lordships would themselves name a sum, as has sometimes been done. As no agreement has been come to, the sum they name is £400.

CLAIM FOR ELECTRIC LIGHT FITTING .

In the Westminster County Court on December 15, before his Honour Judge Lumley Smith, Q.C., the case of Harper *v.* Haynes was heard.

The plaintiff in this case is a dealer in electrical appliances, carrying on business at Westminster, and he sued the defendant, an electrical engineer, to recover payment of an account in respect of fittings supplied to the value of £15.

The **Defendant** appeared and denied his liability, on the ground that the goods were ordered by and supplied to his brother, who was at the time in business for himself.

His **Honour** said it was a very strange story, and he should adjourn the case for the attendance of the brother.

ACTION AGAINST THE BRISTOL TRAMWAYS COMPANY.

At the Bristol County Court, on December 15, his Honour Judge Austin dealt with the action brought by James Cox, a carpenter, of Croydon-street, Easton-road, against the Bristol Tramways and Carriage Company, Limited, to recover £40 for personal damages. Mr. J. Cochrane represented the plaintiff. and Mr. F. E Weatherly (instructed by Messrs Stanley, Wasbrough, and Doggett) appeared for the defendants.

Plaintiff when alighting from a car was thrown to the ground and dislocated his shoulder.

His **Honour** said he believed that plaintiff got off the car when it was in motion. That was one of the most careless things a man could do. There were no grounds for action, so judgment would be given for defendants, with costs.

BRIGHTON AND OVERHEAD WIRES.

At the Brighton Police Court on December 11, the Stipendiary (Mr. C. G. Heathcote), acting as arbitrator, gave a further hearing to the case between the Brighton Corporation and the Postmaster-General with regard to the dispute about the erection of poles in Ditchling-road for the support of the overhead wires of a trunk line of telephone communication between London and Brighton.

The **Stipendiary,** after hearing the evidence, reserved his award, saying the time allowed was anything not exceeding three months, but he hoped to give it much before that.

DAMAGES FOR FALSE IMPRISONMENT.

In the City of London Court, on December 14, Mr. Commissioner Kerr disposed of two cases in which Thomas Britton, Pemberton-terrace, Holloway, and Edward Magill, King-street, Lambeth, sued the National Telephone Company, Limited, for £50 damages each for false imprisonment and malicious prosecution. Mr. W. M. Thompson appeared for the plaintiffs, and Mr. Stephenson for the defendants.

Mr. Thompson said that Britton had been 19 years in the service of the defendant company as a telegraph wire worker. He and Maghill had to adjust some wires and lay new ones. While they were at work in July last on the top of premises in the Strand they were given into custody for stealing old wire to the value of £5. 10s. After two hearings Sir John Bridge at Bow-street Police Court discharged both men. Neither had been able to get work in the same line since, and Britton was now compelled to take labourer's employment to keep his wife and children from starving. By those proceedings the men wanted publicly to clear their characters, which was much more important to them than any money payment which might be given them.

For the defendant company, evidence was given to show that a felony had been committed, and that the defendants had reasonable and probable cause for giving the plaintiffs into custody. They were seen handling the wire, which disappeared and could not be found.

Mr. Commissioner Kerr said there was neither reasonable nor probable cause for the defendants giving the plaintiffs into custody. All the evidence which had been given was consistent with the innocence of both men. The defendants had been a great deal too hasty. He asked if the defendant company would reinstate both men and pay them their wages from the time of the false imprisonment.

Mr. Stephenson said he had no instructions.

Mr. Commissioner Kerr said then he would find for the plaintiffs and give them the full sum claimed, £50 in each case, with costs.

THE "ELECTRICAL APPRENTICES" CASE.

At the Thames Police Court on Thursday, December 11, Samuel Fynn, 40, an electrician, again appeared on remand charged with obtaining various sums of money by false pretences. Mr. Frayling conducted the case on behalf of the Public Prosecutor, and Mr. G. H. Young defended. The particulars of the allegations have already been published. Evidence was now called as to the prisoner's financial position during the time he was taking apprentices.

Mr. Charles Tijon, high bailiff of Bow County Court, proved that 25 executions and arrests for debt had been issued against the accused since 1892; four bills of sale for £30 each had been executed since 1893 on his plant and furniture, and during the past five years the parish authorities had to distrain for rates about twice each year.

The prisoner was committed for trial, bail being allowed.

COMPANIES' MEETINGS AND REPORTS.

CROMPTON AND CO., LIMITED.

An extraordinary general meeting of this Company was held on Monday at the Cannon street Hotel, E.C., Mr. J. Trotter presiding. The purpose of the meeting was to pass a resolution authorising the directors to increase the borrowing powers of the Company from £100,000 to £150,000 on such security and upon such terms as to interest or otherwise as they might deem fit.

The **Chairman** moved the resolution, and remarked that at their meeting in the summer he stated to the shareholders that they were extremely active at the works. The Board, however, had no idea at that time that there would be such a remarkable increase in the business in the past six months as that which had actually occurred. At the date of the last accounts they were paying under £500 a week in wages at Chelmsford, whereas they were now paying over £750 a week. The conditions under which they were working were also about as unfavourable as they could be, for they had not yet gone into their new works. Nevertheless, the private account they had taken out for the six months had shown a very satisfactory profit, which the directors regarded as unusually gratifying in view of the conditions under which they were working, which were anything but economical. They were also expecting, and were practically assured of, a considerable further increase of work under satisfactory contracts which they were just about to enter into. In these circumstances they were obliged to provide extra capital. The stock during the past six months had increased by £9,500, all of which, practically, was not an increase of stock lying in their warehouses, but work in progress throughout the shops; and their good book debts had increased by £15,000. The borrowing powers they required would certainly be less than £50,000, but they had thought it right to ask for the increased power with the view of possibly taking the large contracts they saw before them. He could not, of course, say whether the present season of activity in the electrical world would or would not continue, but at the present time there was a very large amount of business coming to them. If this activity did not continue they would not require to retain the additional money now asked for for any very long period, but he hoped it would continue, and that their business would go on increasing, as that would mean a dividend for the shareholders. They could not, however, expect to be really prosperous before they got into their new works, but they hoped to be in them some time next spring. Their policy had been one of concentration at Chelmsford, and he was glad to be able to inform them that they had quite recently disposed of the Lillie-road premises; such of the work done there as they cared to retain would be taken to Chelmsford.

Mr. R. E. B. Crompton seconded the resolution, saying that they had been at great pains to design new works at Chelmsford of the latest and most economical type, and hoped to get into them by the middle of the spring—in April or May. He could corroborate all that the chairman had said respecting the increased activity at Chelmsford. They had orders which they hoped would fully occupy them for some time to come, and at prices much better than they obtained in the lean years through which they had been passing. He himself, as they knew, was probably one of the greatest sufferers by the non-payment of dividends in the past, and therefore he need scarcely tell them that he personally would strain every nerve to bring about a better state of things in that respect.

Mr. Thornton enquired whether the money to be borrowed would rank before the preference shareholders, or whether new share were to be issued ?

Mr. Evans said they had been told of increased activity and better prospects for several years now, but he had never had a dividend since he had bought his shares. Could the chairman say definitely that next year they would pay a dividend upon the preference shares ? Also he would like to know the rate of interest at which the money would be borrowed.

The **Chairman** said that the money borrowed would rank before the preference shares and after the debentures. Facilities had been offered them at a reasonable rate of interest for obtaining the additional money required. He still thought that there ought to be a writing down of certain of their assets, and he proposed within a reasonable time to bring forward a scheme for dealing with their shares on an equitable basis. He expected that they would realise a very considerable profit on the year, but whether they would be justified in using that for payment of a dividend

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was a different matter, for he did not think it would be right to carry forward items in the accounts which they believed to be over-estimated. The scheme which he intended to bring forward was to deal with this and to allow of dividends being paid.

The resolution was then carried unanimously, and the meeting ended.

BRITISH ELECTRIC TRACTION COMPANY.

The statutory meeting of the British Electric Traction Company, Limited, was held at Winchester House, E.C., on Monday, and was followed by an extraordinary general meeting to approve agreements. Sir Charles Rivers Wilson presided.

The **Chairman** said the Company was registered on October 26 last, and the statutory meeting had to be held, under the Companies' Acts, within four months of the formation of the Company. He believed it was usual to allow rather a longer interval to elapse than the directors had done on the present occasion, but it was necessary to hold an extraordinary meeting, and they had thought it would be more convenient to hold the two meetings on the same occasion. Subscriptions were invited from the public to the capital of the new company, which was formed to take over the business of the Pioneer Company. They proceeded to allotment on £200,000, this being the proportion of capital required to enable them to apply for an official quotation. The shares were taken up by the shareholders of the Pioneer Company and by the Electric and General Investment Company and the latter's financial friends, who had great confidence in the future of electric traction and in the success of the Company. They lost no time in proceeding to work on the lines of policy indicated to them at the meeting on the 5th ult., and as set out in the prospectus It was so very recently that he had the honour of addressing the shareholders and explaining what their policy was, and it was so recently that the present company had absolutely come into active existence, that he need not recapitulate the various engagements entered into or the various schemes intended. He would only just mention one scheme which was very far advanced; that was the contract made with the North Staffordshire Tramways Company for adapting their lines with electrical appliances—he referred to the arrangement with the Brush Company, who, under a contract with the company, would apply electrical apparatus to the North Staffordshire tramways. Other schemes to which he alluded would be taken in their order, or according as the urgency of the case might require. He would take the opportunity of correcting a little misunderstanding which appeared to exist in the minds of certain persons, and which had entailed various enquiries on the part of shareholders. It was that there was some connection between their Company and its objects and the objects of the new motorcar companies. There was no connection whatever between them. The present Company's means of communication was by means of rails and flanged wheels, and the whole thing was altogether different in its essence and its objects from the motorcar movement. Of the new schemes they were promoting, the principal one was that for amalgamating several important tramway undertakings in South Staffordshire. They proposed to deal with four companies, and they intended to ask Parliament for powers for an amalgamation, an extension, etc. They were promoting a Bill in the ensuing session under the title of the Birmingham, Wolverhampton, and District Tramways, with the object of amalgamating various existing lines and equipping them for electrical working. The Bill also provided for making physical junctions between the existing tramways and uniform gauge throughout, and powers were also taken for several considerable extensions. The Wolverhampton Company worked by means of horses, and the Dudley and Wolverhampton Company and the Dudley and Stourbridge Company worked with steam, as did also the South Staffordshire Company. Negotiations had been pending for some time with these three companies for purchasing their undertakings and in one case a definite contract had been concluded, while the negotiations with regard to the others were more or less advanced. It was just possible that they might not be able to arrive at satisfactory terms with one or two of these companies, in which case, much as they would regret it, they would be dropped from the scheme, and the others would be proceeded with. They had, however, a strong expectation and hoped that they would be able to induce all of the companies in question to come into one general scheme. They could not go forward with this important proposal except with the concurrence of the local authorities concerned and with the approval of the Board of Trade and Parliament; and although they hoped to obtain the various consents required, the shareholders must not be surprised if it proved impossible to remove all the difficulties in the way during one parliamentary session. In certain cases they had found that there were distinct advantages in applying the principles and provisions of the Light Railways Act, which was passed last August, to their undertaking, and they proposed immediately to apply this Act to obtaining light railway orders for tramways and extensions of other lines over which at present they had control at Crewe, the Potteries, and Hartlepool. He need not trouble them with respect to Hartlepool, as it was proposed to apply for an order in this case in the name of a local company. With regard to the other companies, they proposed to go to the Light Railway Commissioners and obtain their recommendation to the Board of Trade, who, they hoped, would thereupon issue the orders. As regarded Crewe, there were no tramways of any kind at present in that very important centre, and a resolution had been passed by the Town Council in favour of the establishment of electrical tramways, and in favour of the Pioneer Company carrying out the work. They considered themselves practically the same concern as the Pioneer Company. As regarded the Potteries district, the order they were promoting for tramways was under an arrangement with the local authorities, by which they had bound themselves to make further extensions of tramways in this district. They had a contract with the North Staffordshire Company for the electrical equipment of eight miles of tramways. In the last session of Parliament a provisional order was obtained for extending these tramways over a total length of about 12 miles. The present order was for further extensions in various directions—13 miles in all—so as to connect Longton, Stoke, Hanley, Burslem, Tunstall, and Newcastle-under-Lyme by one system of electrical tramways, making a total network of 33 miles of these tramways in North Staffordshire. At Norwich they were promoting a light railway order for tramways within the city, with extensions to Thorpe, Eaton, Cossey, and other places in the immediate vicinity. Norwich had a population of over 100,000, and was the largest city in the United Kingdom without tramways of any description, and they therefore felt that it afforded scope for introducing electrical tramways. The scheme there would embrace about 13 miles of line. These were the three schemes for which they proposed to apply to the Commissioners to recommend orders. If there was any shareholder who wished to be informed of anything in greater detail, he would be happy to afford all the information in his power.

One question only was asked relating to the system to be adopted, and, in reply to it, the **Chairman** said the system which commended itself to the Board was the overhead trolley system, and it was upon that they had proceeded in every case up to the present. It was entirely a question for the municipality or corporation whether overhead wires should be erected.

This concluded the statutory meeting, and the extraordinary meeting which followed was merely formal, the subject having been already dealt with in the chairman's speech. The **Chairman** moved, and **Sir Charles Freemantle** seconded, the following resolutions: "That the proposed Crewe Light Railway Order, a draft of which has been submitted to the meeting and has been initialled by the chairman for the purpose of identification, be, and the same is hereby, approved, subject to all such additions, alterations, and variations as the Light Railway Commissioners or the Board of Trade may think fit to make therein." "That the Norwich and District Light Railway Order, a draft of which has been submitted to the meeting and has been initialled by the chairman for the purpose of identification, be, and the same is hereby, approved, subject to all such additions, alterations, and variations as the Light Railway Commissioners or the Board of Trade may think fit to make therein." "That the proposed Potteries Light Railway Order, a draft of which has been submitted to the meeting and has been initialled by the chairman for the purpose of identification, be, and the same is hereby, approved, subject to all such additions, alterations, and variations as the Light Railway Commissioners or the Board of Trade may think fit to make therein."

Each of these resolutions having been put separately and carried unanimously, the proceedings terminated. A confirmatory meeting will be required in the usual course.

ELMORE'S PATENT COPPER DEPOSITING COMPANY.

The ordinary general meeting was held on Saturday, December 12, at the Cannon-street Hotel, under the presidency of Mr. A. S. Elmore, managing director.

The **Chairman**, in moving the adoption of the report and accounts, said that the directors had to congratulate the shareholders upon the fact that the Company continued to show a satisfactory improvement over the results of former years. Their business had continued to prosper, notwithstanding the keen competition to which they had been subjected and the drawback of not having sufficient working capital, which they alluded to specially in the third page of the report, in which they made the following appeal to the shareholders – viz.: "The directors earnestly ask the shareholders to thoroughly consider the Company's position. In the past, very sanguine anticipations were prematurely expressed — £70,000 was distributed in dividends which should have been husbanded for trading purposes, and about £70,000 was sunk in freehold land, involving a very heavy annual charge for interest The natural consequences were that the Company was denuded of working capital long before it could hope to overcome the initial difficulties common to every new enterprise, or to show the real merits and possibilities of the business. Only very small and most inadequate further sums of capital could be raised with the utmost difficulty and on exceedingly onerous terms; hence the business has never yet had a fair chance, although, thanks to the devotion of some of the Company's servants, a moderate success has been shown sufficient to convince every observer that the Elmore process produces an altogether unequalled finished article at a very low cost. Having to deal with a very costly form of raw material at £40 to £50 a ton, as contrasted with an iron foundry, where the raw material is perhaps only one-twentieth the cost of copper, a large capital is necessary for stocks in trade, and to allow the usual trade credit to customers; thus our competitors' accounts show their stocks to be many times the amount of ours, exclusive of very large cash and debtor balances. The shareholders cannot fail to see that without sufficient funds in hand the works cannot by any possibility produce large results, and all that the present directors—who share no responsibility for the mistakes made in the earlier years - could possibly hope to accomplish has been accomplished—namely, to show that a profit can be made even under the most unfavourable conditions, and thereby enable the shareholders to appreciate the real merits of the business and its potential success." The result of these operations was that

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they showed in the manufacturing account a gross profit of £6,895. The Company had never had so many contracts and orders in hand as at the present time. In conclusion, the Chairman alluded to the fact that the directors were contemplating the amalgamation of this Company with the Elmore's Wire Company, the two companies being carried on as one, but the rights of the shareholders in each being scrupulously regarded. The scheme was not ripe at present, but the directors would carry it out and submit it to the shareholders at the earliest possible date.

The report was adopted.

VENEZUELA TELEPHONE COMPANY.

The annual general meeting of the Venezuela Telephone and Electrical Appliances Company, Limited, was held on Thursday, December 10, at 28, Victoria-street, S.W., Sir Douglas Fox presiding.

The **Chairman** stated that the shareholders had every reason to be satisfied with the way in which the business had been conducted in Venezuela, and with its gradual and steady growth. The net revenue of the Company during the past year amounted to £9,334, which enabled the Board, after payment of debenture interest, to recommend the declaration of a dividend of 4 per cent. for the year on the capital of the Company, and to place £2,500 to the reserve fund. The number of subscribers had increased from 2,287 on June 30, 1895, to 2,524 on June 30, 1896, since which date there had been a further increase of about 100 subscribers.

CONTRACTS FOR ELECTRICAL SUPPLIES

CONTRACTS OPEN.

Paris.—Tenders will be received on 30th inst. at the Assistance Publique, Paris, Avenue Victoria 3, for a telephone and electric bell installation.

Denton.—Specifications and tenders are invited for an electric light installation. Apply to Messrs. John Lever and Co., galloon manufacturers, Denton.

Brussels.—Tenders will be received on December 24 at the Brussels Bourse for the supply of wooden telegraph poles for the Belgian telegraph service.

Elberfeld.—Among other miscellaneous stores, tenders will be received at Elberfeld on December 30 for the supply of electric light carbons for the Prussian State Railway.

Saint-Yvon (France).—Tenders will be wanted on January 31 for an electric lighting installation (to replace 1,500 gas lights) at the lunatic asylum at Saint-Yvon, in the Seine Inferieure. Application to the asylum authorities.

Salford.—The Corporation require tenders for the supply of one mile of high-tension armoured cable. Tenders to be delivered not later than 22nd inst. Full particulars to be obtained of the Gas Engineer, Gas Offices, Bloom-street, Salford.

Karlsruhe.—Tenders will be received on January 2 next for an electric lighting installation for the railway station and pier at Constance for the Grand Ducal Railway Authorities. Particulars are obtainable for 10 marks (10s.) from the Generaldirektion, (Centralbureau) Grossh. Badischen Staatseisenbahnen, Karlsruhe, Germany.

Harrogate.—The Town Council are prepared to receive tenders for wiring the Municipal Offices, Victoria Baths, Market Hall, and Public Library; also for electrical fittings for the same. Specifications and forms of tender can be obtained at the office of the Electrical Engineer, Montpellier-gardens. Tenders must be delivered on or before January 1, 1897.

Hull.—The Corporation invite tenders for a lease of the tramways authorised to be constructed by the Tramways Orders Confirmation (No. 1) Act, 1896. Tenders to be delivered by February 1, endorsed "Tramway Tender," at the office of Mr. R. Hill Dawe, town clerk, Town Hall, Hull, from whom all particulars and conditions of tender may be obtained.

Colwyn Bay.—The Urban District Council invite plans, particulars, and estimates, etc., for a scheme of electric lighting for their district, the powers for which they obtained last session. To the author of the scheme considered the best a premium of £30 will be paid, and in the event of the work being carried out such premium must be considered as part payment of the engineer's commission. To the author of the scheme considered second best a premium of £20 will be paid. Further information will be received on personal application to Mr. Wm. Jones, A.M.I C.E., the Council's surveyor. The schemes must be sent in not later than January 12, 1897. Further particulars are contained in an advertisement in another part of the paper.

RESULTS OF TENDERS.

Chelmsford.—The contract for the wiring, switches, etc., in connection with the lighting arrangements at Messrs. Crompton and Co.'s new works has been given to Messrs. T. H. P. Dennis and Son.

Londonderry.—The tender of Messrs. Braulik, of London, for the supply of carbons for the year from January 1, 1897 has been recommended for acceptance by the Lighting Committee of the Corporation.

Berlin.—Ten firms tendered for the supply of telegraph posts to the Prussian State Railways on December 10. This gives over 80 prices for different sizes, and these again differ according to place of delivery. The head of the list is Schneider, of Guben, but the firm to whom the contract will go is not stated.

Cardiff.—The lighting of the new General Post Office here has been placed in the hands of Messrs. J. B. Saunders and Co., of Cardiff. Thirty-four arc lamps and nearly 600 incandescents will be employed.

Posen.—For the supply of telegraph posts to the State Railways on December 5, 11 firms tendered. The first on the list is Von Wilzewsky (Wronke) at prices ranging from the equivalents of 3s. 11½d. to 1s. 4d. according to size.

Ayr.—The Town Council have placed the contracts for boilers, engines, and generators with Messrs. Siemens Bros. and Co., the price being £7,037, and for transformers, switches, etc., with Messrs. John Fowler and Co., Leeds, the price being £645. 15s.

Morley.—The Electric Lighting Committee, after visiting Halifax and Manchester, and inspecting the engines of Messrs. Pollit and Wigzell and Messrs. Goodfellow, recommended that the tender of the Electric Construction Company, providing Messrs. Pollet and Wigzell's engines, be adopted. This has been confirmed by the Council.

BUSINESS NOTES.

Ipswich.—The Town Council have agreed to apply to the Board of Trade for an electricity provisional order.

Edinburgh.—The Corporation contemplate the rearrangement of and additions to the electric lighting of the market.

Maidenhead.—The Town Council have resolved to apply for a provisional order for lighting the town with electricity.

Kenilworth.—It is understood that the National Telephone Company contemplate opening an exchange here next year.

Swaffham (Norfolk).—The Guardians have resolved to fix an electric bell between the receiving ward and infirmary buildings.

St. Pancras.—The London County Council have agreed to lend the Vestry £6,540 for an electric light installation at Stanhope-street.

Dundee.—The tramway company propose to introduce a motorcar service experimentally on several routes in the city and suburbs.

Chester.—A further sum of £6,000 has been placed to the credit of the Electric Lighting Committee to pay towards the cost of the electric lighting of the city.

Leith.—At a special meeting of the Town Council a resolution was passed approving of the draft provisional order for the Board of Trade on electric lighting.

Withington.—The seal of the District Council has been affixed to the memorial to the Board of Trade for powers to provide the district with electric light, etc.

Bootle.—The Mayor stated at the Town Council meeting that the report of the deputation on electric lighting would in due time be presented to the Council.

Smoking Concert.—The staff of the London Electric Lighting Company held a smoking concert on Tuesday night at the Masons' Hall Tavern, Basinghall-street.

Pemberton.—Some correspondence on the question of electric light was read at the District Council meeting, and the further consideration of the subject was deferred for a month.

Burton.—The Town Council are applying to the Local Government Board for power to borrow £1,000 for alterations at the institute and for lighting that building with electricity.

Islington.—The Electric Lighting Committee recommend the Vestry at to-night's meeting to erect an arc lamp and transformer in St. John's-park, at a total estimated cost of £79. 14s. 6d.

Kensington.—The Vestry have discussed the question of the new Piccadilly and Brompton electric railway, and eventually referred the subject to the Law and Parliamentary Committee.

St. Saviour's, S.E.—The St. Saviour's Board of Works have instructed the General Purposes Committee "to enquire as to the feasibility of substituting electricity for gas as a street illuminant."

Ealing.—The Electric Lighting Committee have instructed the electrical engineer to enquire into the report upon the system adopted elsewhere of supplying electric light on the "penny-in-the-slot" principle.

Brush Electrical Engineering Company.—The transfer-books of the 4½ per cent. second debenture stock will, in view of interest payable on January 1, be closed from to-day (Friday) to that date, both days inclusive.

Huddersfield.—The Town Council have resolved to promote a Bill in the next session of Parliament to enable the Corporation to "run carriages on the tramways to be worked by steam electric, or mechanical power."

Fleetwood.—The Urban District Council have approved the amended deed of transfer of the Fleetwood Electric Lighting Order, 1890, to the Fleetwood and District Electric Light and Power Syndicate, Limited.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended December 13 amounted to £1,098, as compared with £1 081 in the corresponding week of the previous year, being an increase of £17.

City of London Electric Lighting Company.—The transfer-books and register of holders of 5 per cent. debenture stock will be closed on 31st inst. for the purpose of preparing the warrants for the interest due January 1.

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Whitehaven.—The Town Council have declined the offer of the Electrical Power Storage Company, Limited, with reference to the future maintenance of the storage battery, and the work is to be done by the Corporation workmen.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ended December 11 were £1,876. 17s. 3d., compared with £1 710 11s. for the corresponding period of last year, being an increase of £166. 6s. 3d.

Electric Manufacturing Company, Limited.—This Company has been registered, with a capital of £3,000 in £1 shares, to carry on the business of merchants importers, exporters, and manufacturers of all kinds of goods, chattels, and merchandise.

Correction.—We are informed that Mr. W. H. Coles, who was one of the candidates for the Shoreditch electrical engineership, and who we stated had in hand a station at Pontypool, had nothing to do with that station, the engineer to which is Mr. P. J. S. Tiddeman.

Buluwayo.—At the meeting of the Buluwayo Waterworks Company, Limited, the Chairman stated that they hoped to have the electric lighting machinery fixed by February or March. The plant, which has been obtained from New York, provides for 4,000 16-c.p. lamps.

Henstead.—The Highways Committee of the Rural District Council have dissented from the proposal of the electric tramway company to take over certain roads in their district, and have resolved that a letter to this effect be sent to the Light Railways Commissioners.

Electric Railways and Churches.—The City Church Preservation Society purposes taking prompt action with a view to preventing the threatened destruction of St. Mildred, Bread-street, in connection with the scheme for the construction of the new electric railway.

Swadlincote.—It was stated at the District Council meeting, with regard to the application for an electric lighting order, that the committee had instructed Prof. Robinson to confine the compulsory area to the streets included in the estimate of cost as contained in his report.

Leeds.—The Highways Committee have passed a resolution recommending the City Council to authorise the committee to proceed with the extension of the tramways up York-road to a point near the entrance to Victoria-avenue, by virtue of the Leeds Corporation Tramways Act, 1896.

Bolton.—The Town Council have approved of a petition for leave to bring in a Bill in the next session of Parliament for extensive improvements, including powers for running tramway cars by electricity, and also for extending the tramways. The ratepayers have approved of the Bill.

City and South London Railway.—The returns for the week ended December 13 were £1,075, compared with £1,014 for the corresponding period of last year, being an increase of £61. The total receipts for the half-year 1896 were £23,022, compared with £21,541 last year, being an increase of £1,481.

Madagascar.—Applications have been received by the French Government from six Parisian syndicates for railway concessions between Tamatave and Antananarivo, one of the proposals being for an electric line. It has been decided that the concessions shall under no circumstances be given to foreigners.

City and South London Railway.—Work has not yet been commenced beneath the church of St. Mary Woolnoth, but expert opinion has been taken upon the possibility of making the station without endangering the church, and it is stated that, from an engineering point of view, the project is quite feasible.

Electric and General Investment Company, Limited.—The directors have declared an interim dividend on the capital paid up on the ordinary shares at the rate of 10 per cent. per annum for the six months ended November 30, which is payable on and after January 1 to shareholders registered on the former date.

Westralian Motor Carrying Company, Limited.—This Company has been registered, with a capital of £7 in £1 shares, to carry on the business of carriers, transport agents, coach and carriage builders, cycle, motor, carriage, and autocar manufacturers, dealers and repairers, engineers, machinists, etc.

Agency Change.—Messrs. J. P. Hall and Co., of Oldham, inform us that Messrs. Girdlestone and Co. have ceased to act for them as London agents; they will therefore feel obliged if their customers will forward all enquiries and orders direct to them at Oldham until such times as they are able to make other arrangements.

Yarmouth.—The Surveyor reported at the Town Council meeting that additional applications for electric light had been received for 282 lamps, the total number of customers now being 195 for 9,729 lamps. Last month £213. 2s. 2d. was earned beyond cost of production; the cost of capital and sundry charges amount to £150 a month.

Bournemouth.—The Bournemouth and District Electric Supply Company, Limited, appealed before the Branksome magistrates on Monday against the assessment of their property in the parish of Branksome. The result was a reduction of the net assessment from £1,900 to £465. 18s., which is as it stood in 1895. Notice of appeal was given.

Carlisle.—As a considerable portion of the period prescribed by the Electric Lighting Order, 1895, for the laying of distributing mains in certain streets has elapsed, the Council have authorised the General Purposes Committee to call in a consulting electrical engineer to advise as to the best means of carrying into effect the powers conferred by that order.

Battersea.—The Vestry have decided that ground should at once be secured for a central electric light station, and that the Vestry should purchase of Mr. G. Neal Grove Wharf and Canada Wharf for the sum of £8,500, and land and premises in the Lombard-road of Mr. Audoire for the sum of £5,400.

Plymouth.—The Borough Surveyor reported at the Town Council meeting that the electrical engineer had obtained the electric cables to be laid in Old Town-street and Ebrington-street, and that he proposed to lay them forthwith, and he pointed out the desirability of completing the footways in these streets simultaneously with the execution of the electrical works.

Electric Gun Mechanism.—The preliminary firing trials of the new designs of mountings for the 12in. breechloading wire guns to be fitted on board the battleships "Cæsar" and "Illustrious" have proved in every way satisfactory. The special features of these gun mountings are the ease and rapidity with which they can be operated by hydraulic, electric, or hand power.

A Brilliant Notion.—The following interesting paragraph has been manufactured by one of the London news agencies and circulated widely among the London and provincial Press: "It is said that the lighting of certain of the London prisons by electricity is under consideration, and it is proposed to erect a special description of tread-wheel to supply the motive power."

Southport.—At the meeting of the Town Council Councillor Hesford proposed the adoption of the minutes of the Electricity Committee, omitting the clause as to the insurance of the works and plant. In consequence of the insurance companies having increased their rate from 5s. to 10s., the committee wished to consider the matter further. The minutes were adopted.

Bangor.—According to the minutes of the Lighting Committee which were adopted at the Town Council meeting, it appeared that the Mayor was elected chairman for the ensuing year. With regard to the electric light provisional order, letters were received from the town clerk andthe parliamentary agent on the subject of the bill of costs. The Council were recommended to pay the bill.

Dublin.—Mr. Beattie stated at the meeting of the Corporation that he was endeavouring to collect all the information that would be required to enable the Council to deal with the tramway question. He had purposely delayed calling a meeting until the law agent had supplied him with the information he required, and which he hoped to have completed about the first week in January.

Blackpool.—A commencement has been made with the laying of the new cable, and the new flywheel alternator by Ferranti is being erected and is expected to be running about the end of January. Mr. Quin, the borough electrical engineer, attended a meeting of the Tradesmen's Association recently, and explained in detail the new system of charges which will come into operation on January 1.

Glasgow.—The cars on the new subway railway are lighted by electricity. The Corporation have decided to have the electric light switched on in the principal thoroughfares and crossings during fogs. The Statute Labour Committee have agreed to receive a deputation of the National Telephone Company in order that the question of underground wayleave for the telephones of the city might be discussed.

Silverdale (Lancs.).—A letter was read at the Urban District Council meeting from the Board of Trade enclosing a communication from the Windermere and District Electricity Supply Company, in which the company expressed their willingness to exclude Ulverston and Grange from their scheme if these places desired it. The letter was referred to the General Purposes Committee for further consideration.

Acetylene Gas Lighting Development Syndicate, Limited.—This Company has been registered, with a capital of £1,200 in £10 shares, to acquire, develop, and turn to account any patents relating to the manufacture of chemicals used in the production of acetylene gas and carburetted hydrogen, and to acquire the benefit of an agreement with V. B. Lewes and the Comptoir International, Limited.

Woking.—The Sanitary and Lighting Committee reported at the Urban District Council meeting that they had received a letter from the electric lighting company stating that they would endeavour to improve the lighting of the streets. The committee directed the company to be informed that the lights supplied were not in accordance with their contract, and that they be called upon to supply lights according to contract.

City of London.—At the meeting of the Commissioners of Sewers the Streets Committee recommended that the City of London Electric Lighting Company should be required to provide a means of testing the supply of energy to the public lamps, by which the Commission would be enabled to ascertain whether the said lamps were supplied for the full time and at the full rate of energy defined in the contracts. The report was adopted.

Sedgley.—At the District Council meeting a letter was read from Mr. F. F. Bennett, of Manchester, offering his services in case the Council proposed to introduce electricity in the district. The letter was laid on the table. It was reported that the syndicate had laid before the Council plans of the new tramway from the Fighting Cocks to Bilston. It was decided to arrange a conference on the subject with Coseley District Council.

Electric Omnibuses.—It is reported that the truck of one of the new electric omnibuses made a trial trip in the early hours of Wednesday morning, about nine miles of the London streets being traversed. According to a News Agency, who appear to have been the only representative of the Press favoured with the information, the trial was very satisfactory, but we fail to see the necessity for so much secrecy if the machine is really a good one.

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Bromley.—The committee of the whole Council reported at the District Council meeting that they had considered further correspondence from Messrs. Waterer and Dickins and from Mr. H. Podger on the subject of the transfer of the electric lighting provisional order to a syndicate of ratepayers, and had adjourned the subject for further consideration, the clerk and surveyor being instructed meanwhile to obtain information bearing on the matter.

Llandudno.—A special meeting of the Urban District Council has been held to consider the parliamentary notice, plans, etc., deposited with the clerk to the Council with reference to a light railway proposed to be constructed by the Llandudno and Colwyn Bay Light Railway Syndicate from Colwyn Bay to Llandudno. It is intended that the motive power shall be electricity, the gauge to be 3ft. 6in. The Council by seven votes to six rejected the scheme so far as Llandudno was concerned.

Bucharest.—Some time ago the municipal authorities of the city of Bucharest advertised for schemes and estimates of a system of artificial lighting to replace petroleum, but under conditions which made it almost impossible for electric lighting or gas to compete on any of the existing systems of distribution. The authorities have now advertised for tenders for petroleum lighting for one year, with ability to renew. The inference, therefore, is that the former scheme is at present in abeyance.

Projected Scottish-Icelandic Cable.—A Reuter's telegram states that the establishment of a telegraph cable between Scotland and Iceland *viâ* the Shetland and Faröe Islands, is contemplated by an English telegraph company acting in connection with influential Icelanders. Mr. Mitchell, a barrister, and Mr. Thordall, an Icelandic merchant of London, representing the company, and Mr. Haldorsson, a merchant of Iceland, have arrived at Copenhagen in order to enter into negotiations with the Danish Government concerning the scheme.

Lewisham.—At the meeting of the District Board of Works the Clerk reported the deposit at the Board's offices by the Blackheath and Greenwich District Electric Light Company, Limited, of notice of their intended application to the Board of Trade for a provisional order under the Electric Lighting Acts to empower the company to supply electricity in part of the parish of Lewisham, and giving notice that any representation or objection respecting the application must be addressed to the Board of Trade on or before January 15.

Isle of Man.—In view of the fact that the Imperial Parliament has passed a Bill authorising the use upon certain roads of motor-cars, there has been introduced into the Manx Legislature, at the instance of Mr. James Mylchreest, who represents Castletown in the House of Keys, a Bill to legalise the use of light locomotives, not to exceed in weight four tons, and so constructed that no smoke or visible vapour is emitted therefrom. Fourteen miles is fixed as the maximum speed of travel along public highways. It is provided that yearly duties shall be charged.

Grange.—At the Urban District Council meeting a letter was read from the Board of Trade enclosing a communication from the Windermere and District Electricity Supply Company, in which the company expressed their willingness to exclude Ulverston and Grange from their scheme if these places desired it. Councillor Midgley considered that it might possibly be detrimental to the interests of Grange to be left out of the scheme, and therefore he proposed that the letter be referred to the General Purposes Committee for further consideration. This was agreed to.

Market Deeping—At the Town Council meeting the Mayor read the report of Mr. A. Collins, electrical engineer, of London, on the possibility of lighting the dock by electricity. He presented a scheme, and estimated the cost of providing the necessary plant at £1,294. 4s., and stated that the annual cost of maintenance would amount to £152. 10s. He quoted statistics that the gas consumed at the dock cost £176. 6s 6d. per year, and that the candle-power was 364, and added that under his scheme the candle-power would be 9,660. The scheme was unanimously adopted.

Brighton.—The borough engineer (Mr. F. J. C. May) has in hand temporary works for the protection of the Madeira-road, which, of course, also includes the protection of Mr. Volk's electric railway. The Works Committee have recommended for adoption the scheme prepared by Mr. May for the erection of a groyne and sea-wall at a cost of about £30,000, and if this is carried out, it is probable that Mr. Volk will be able to come to some agreement with the Corporation which will practically ensure the absolute protection of the railway from serious damage by the sea.

Prizes for Motorcars.—The detailed regulations for the trials of self-moving vehicles for light and heavy loads, for which the Royal Agricultural Society have announced their intention to offer prizes, have been issued. The competition will be in two classes—(*a*) for light-load vehicles which would take the place of light spring carts for carrying loads up to two tons; and (*b*) for heavy-load vehicles capable of carrying four tons. Two prizes of £100 and £50 will be offered in each class. The trials will take place early in June next, and will include a run, out and back, over a distance of 50 miles.

Belfast.—The Electric Committee have authorised the engineer to notice consumers that the pressure at which electric current will be supplied to them will be uniformly 220 volts in place of 110 and 220 as heretofore, and that fittings will have to be provided to suit the pressure in future. A large twin-screw steamer has just been launched from the shipbuilding yard of Messrs. Workman, Clark, and Co., Limited, which will be fitted throughout with an installation of electric light by Messrs. W. C. Martin and Co., Glasgow, including Suez Canal searchlight, sidelights, and powerful cargo lamps at all hatchways for night work.

Prince Motor Syndicate, Limited.—This Company has been registered, with a capital of £50,000 in £1 shares, to carry on, in all or any of their respective branches, the businesses of manufacturers of and dealers in motors of every description, cycles, carts, ships, flying-machines, etc.; as electricians, mechanical engineers, etc.; to obtain licenses under the Hackney Carriage Act and otherwise, and to carry on in all its branches the business of omnibus, carriage, and launch proprietors and carriers of passengers and goods; and to construct, purchase, lease, or otherwise acquire any rail or tram way, and to equip, maintain, and work the same.

Coventry.—At a meeting of the General Works Committee of the City Council the question of the proposed extension of the electric tramways through the city from Chapple Fields on the west to Stoke on the east came up for consideration. The laying of the trams through the narrow and crowded thoroughfares of Smithford-street, High-street, and Earl-street was strongly objected to, but in the end it was arranged that the Corporation should not object to the tramways company taking the powers they asked for, provided a clause be inserted in their Bill that the tramways shall not be laid through the thoroughfares named without the consent of the Council.

Lambeth.—At the meeting of the Vestry the Clerk (Mr. H. J. Smith), in a special report with regard to the electric lighting order, stated that the Board of Trade had intimated that they would not sanction the transfer of the Lambeth electric lighting order to a private individual, but would require a company to undertake a transfer. It has been arranged by the holders of the order that this should be done by a company known as the South London Electrical Supply Corporation, Limited. This company, which had been registered with a capital of £325,000, would not go to the public for subscription, the Board having sanctioned £200,000 being underwritten.

Lee.—The General Purposes Committee reported at the meeting of the Board of Works that they had considered a notice from the Blackheath and Greenwich District Electric Light Company of an application for a provisional order authorising the company to provide electric lighting for certain parts of Charlton, Eltham, Kidbrook, Lee, etc. They recommended that the company should be informed that the Board could not at present consent to the proposed provisional order, and wished to know whether the company would be prepared to extend the area to the whole, or what larger part of the district. The recommendation was agreed to without discussion.

Hove (Brighton).—The Hove Electric Lighting Company, Limited, have given notice that on and after January 1 next an important reduction will be made in the charge for current by reducing the time per day for the charge at 8d. per unit to one hour in lieu of two hours as at present. The effect of the new arrangement will be that after the consumer has used sufficient electrical energy to supply the maximum number of lights switched on at any one time for one hour per day, all energy consumed by him subsequently will be at the rate of 4d. per unit. The charge on and after the above date for electrical energy for motive power will be at the rate of 3d. per Board of Trade unit.

Ayr.—The extension of the electric light has been again considered at the Town Council. Mr. Craig alleged that the present plant had failed to work in parallel, and that the test for this essential had not been applied by the engineer, Mr. Hammond. The Treasurer said that was entirely a mistake. Mr. Hammond had made a statement which he took for an assurance that the parallel test had been successfully applied. Mr. Pink, the Corporation electrical engineer, said the test had never been applied in a manner satisfactory to him. He had endeavoured to apply it himself unsuccessfully. It was, after some further discussion, agreed to proceed with the extension of the plant, doubling the producing power.

Stafford.—Alderman W. H. Peach mentioned at the Town Council meeting that the assessment of the electric lighting works, plant, etc., had been increased from £250 to £380. That the amount was not larger was due to the efforts of Mr. Bell, the manager. The Electric Lighting Extension Syndicate, Limited, had applied for special terms for the supply of electricity by means of penny-in-the-slot meters, but the committee did not think that the Corporation should accede to the request. The department were supplying twice as much electricity as they were last year, and it was the wish of the committee that the gas and the electric light undertakings should grow up side by side, the one not to supersede the other.

Oswestry.—A motion stood on the agenda of the last Council meeting in Councillor Davies's name in favour of the discontinuance of the electric light in the Cross Market. The Town Clerk said before Mr. Davies brought forward his motion it would, perhaps, save time if he read one of the clauses of the agreement with the electric lighting company, which provided that it was necessary for either side to give notice of their intention to discontinue the contracts. The proposition of Councillor Davies was therefore no good until next September, when he would be at liberty to move a resolution on the subject. Councillor Lacon said one of the electric lamps in the Cross Market went out of order on the previous Saturday night. The Chairman said that if only one lamp was out of order he was afraid it would occur again.

Newington.—At the meeting of the Vestry the Electric Lighting Committe recommended "(*a*) that the application to the Board of Trade by the County of London and Brush Provincial Electric Lighting Company, Limited, for a provisional order to enable the said company to supply electricity for both public and private purposes within the area of and under the jurisdiction of the Vestry be opposed: (*b*) that the memorial submitted be sealed and

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forwarded to the Board of Trade, applying for a provisional order under Section 4 of the Electric Lighting Act, 1882, for the supply by the Vestry of electricity for lighting purposes, both public and private, within the area of the parish; and (c) that a cheque be drawn in favour of the Board of Trade for £50 and lodged with the memorial, as required by the rules of the Board." After an uproarious discussion, during which some strong language was used, the recommendations were agreed to.

A New Gold Recovery Process.—A company, called the Haycraft Gold Reduction and Mining Company, has been formed, with a capital of £200,000, to acquire the exclusive rights of the process for Western Australia, and to develop and work about 36 acres of gold-mining leases in Kalgoorlie, Western Australia. The company will also take over the plant and a leasehold battery station covering five acres in Kalgoorlie. The purchase-price to be paid to the vendor syndicate is £75,000, of which £55,000 will be paid in shares. The present issue consists of 95,000 shares of £1 each. The process consists of a combination of electrolytic chlorination and electro-amalgamation. These operations are carried on in one vessel at boiling temperature, the ore being treated as it is received from the crushing mill. After about two hours' treatment from 80 to 97 per cent. of the gold, it is claimed, is extracted, as against from 70 to 91 per cent. by other methods.

South London Electric Supply Corporation, Limited.—This Company has been registered, with a capital of £325,000 in £5 shares, to obtain by purchase the Lambeth Electric Lighting Order, 1892, and all or every interest therein of one Charles William Sax; to adopt and carry out three several contracts—viz., the first, made between Messrs. Manlove, Alliott, and Co., Limited, of the one part, and W. R. Jackson, for this Company, of the other part; the second, made between the British Insulated Wire Company, Limited, of the one part, and W. R Jackson of the other part; S. Z. de Ferranti, Limited, and the said W. R. Jackson—the said agreements bearing date December 3, 1896; to act as undertakers for the supply of electricity for lighting and other purposes within the parish of Lambeth, or elsewhere; to erect a destructor or destructors to deal with refuse; as manufacturers of and dealers in chemical substances, mortar and artificial stone, clinkers, and to distil coal or other fuel; to promote railways, tramways, auto-car companies, hydraulic works.

Cupar.—At a meeting of the County Road Board of the Fifeshire County Council the Chairman stated that the committee were asked to get the price of a telephone system extending to 101 miles, taking the district of Leven as far as Anstruther. They had got an offer to do the work for £1,900 from a London firm, and another firm had offered to do it for £2,000. A Glasgow firm had offered to execute the work for £1,955. Mr. James Pollock, electrical engineer of that firm, had called upon him on the previous night, and had offered to provide the best wire used and the best instruments at the above price, and to uphold them for six months after they were erected. He thought the cost would not exceed £2,000, and he recommended that the matter be remitted to the committee to carefully consider the estimates and bring up a report. Colonel Erskine suggested that the telephone be put into the hospitals, as it would be very useful in these. This was agreed to. The Chairman recommended that they ask the County Council to allow that Board to accept the lowest or best offer up to £2,000 for a private telephone system. This was also agreed to.

Exeter.—The Electric Lighting Committee report a continued increase in business, but the new transformer has prevented any additional strain on the works. A 24 hours' supply is now given. A memorial was read at the last meeting of the City Council from 220 ratepayers asking the Council to take into consideration the desirability of reducing the charge to 4d. per Board of Trade unit. It would greatly retard the growth of electric lighting in the city if the Corporation maintained the present maximum charge of 6d. per unit. Mr. Wreford moved that the memorial be referred to the Electric Lighting Committee. The resolution was carried, and another communication from Messrs. Massingham and Co., Taunton, was read, stating that should the Corporation accede to the request contained in the memorial they would be prepared to make arrangements for undertaking the free wiring and complete installation of the electric light wherever supplied from the Corporation mains, without any initial charge to the consumers, merely charging a rental sufficient to pay a fair rate of interest on the outlay. This communication was also referred to the Electric Lighting Committee.

Kingstown.—At the meeting of the Commissioners Mr. M'Cullagh said he had been a good deal agitated at the last monthly meeting in reference to the condition of the two men who had been injured on the electric tramline, and he had made some strong representations as to the rectification of the then existing condition of things. He was happy to say from his experience and close observation that he thought a great improvement had since been effected. The tramway officials were anxious to meet the requirements of the public, and there had been no cause of complaint or any accident of a serious character. It would be a great improvement if they could get the interlacing of the lines effected in the congested portion of George's-street. He regretted that anything he had said should have had the effect of causing the dismissal of a responsible official, and, under the circumstances, he would be happy to do all he could to have him reinstated in his position. The Chairman said he was aware that the tramway company were making the greatest possible efforts to devise a scheme which would be most easy for everybody. That scheme would probably be laid before them early in the new year. Mr. Buckley said the Board had no official information with respect to the proposed interlacing of the lines in George's-street. The subject then dropped.

Bray.—A letter was read at the meeting of the Commissioners from Mr. Lilley, hon. secretary, Bray Pier and Tramways Syndicate, in reply to a communication from the Commissioners informing the syndicate that a guarantee for the satisfactory carrying out of the schemes would be required. Mr. Lilley stated that, so far from taking exception to the suggestion, his syndicate desired to conform in every possible way, and asked what guarantee would be required. The Chairman suggested that the syndicate should lodge £5,000 as a guarantee for the pier and £5,000 for the tramway. The Town Clerk said that it had been suggested that the money was to be lodged in the names of trustees—one on behalf of the township and another on behalf of the syndicate. The sum to be invested in approved securities, and the full amount, with the interest earned on it, handed to the syndicate or company. The majority of the Commissioners considered the sum named by the chairman as too high, and ultimately it was decided that £5,000 should be lodged in the hands of trustees as a guarantee for the due carrying out of the two schemes; and the town clerk was directed to inform Mr. Lilley of the decision, and also that his syndicate should state what they were disposed to pay for way-leave for trams and rent for pier.

Catalogues.—We have received from Messrs. Mavor and Coulson, 47, King-street, Bridgeton Cross, Glasgow, a copy of their latest electric light and power catalogue. The book is well bound and, which is exceedingly convenient, it is thumb indexed. It contains illustrations of combined plant, dynamos, and motors, and also full prices in tabular form, a description of the "C. C." system of concentric wiring, and illustrations of switchboards, switches, fuse boxes, junctions, terminals, connections for arc lamps, and all kinds of fittings, etc. Instructions are also given for making "C. C." joints, and these instructions are fully illustrated with diagrams. The catalogue is worthy of careful attention, for the figures, illustrations, and reading matter are alike of a most useful character; but space does not permit of our entering into detail.—Messrs. Samuel Withers and Co., of Park Works, West Bromwich, send us an illustrated list of the fire and burglar resisting safes, iron doors, and frames, deed boxes patent lever locks, galvanised tanks, etc., of which they are the patentees and manufacturers. The testimonials alone are a sufficient recommendation of the great value of the security against fire and burglars which Messrs. Withers afford, but if additional recommendation is required references are given to nearly 40 banking and railway and other companies and corporations.

Sheffield.—The City Council have unanimously approved the Sheffield Corporation Street Widenings and Tramways Bill, which seeks powers to make tramway extensions. Mr. Marsh drew attention to a paragraph in the minutes which stated that the Mechanical Traction Syndicate, Limited, had made an offer to supply cable or electric traction for the existing tramways, and portions of the proposed extension, on a lease being granted to them for not less than 21 years at a rent of £30,000 per annum, and on other conditions. The committee stated in their reply to the syndicate that they were not prepared to recommend the Council to consider proposals "from any company." He suggested that that might be amended to read "from this company," so that the Council might have the opportunity of considering any further proposal, if one were made. Alderman Clegg, in reply, said it must not be assumed, because they desired to know whether cars could be adapted to electric cars, that they had resolved on any special form of traction. The fact was they were going to order new cars, to meet the extra demands of the traffic, and they thought it desirable to have cars which, in case they recommended electricity for motive power could be adapted for use. That was the only object contemplated in the recommendation. With reference to the offer of the Mechanical Traction Syndicate, the committee purposely disposed of it in a summary manner, because they wanted to let people know that now the Corporation had possession of the tramways they did not intend to let anybody else come in. Moreover, if the Council knew all the conditions which the proposal of the syndicate contained, they would come to the conclusion that the offer of £30,000 was not a very great thing after all.

Cardiff.—On the presentation at the Council meeting of the report of the Tramways Committee recommending the purchase of the lines and depôts of the Cardiff Tramways Company for £61,000 and that the lines be leased to the company for 15 years at 5½ per cent., with certain reservations, Councillor Robinson asked the town clerk when the whole of the lines of the Provincial Tramway Company could be acquired. The Town Clerk stated that there was no part of the lines which could not be acquired by the Corporation in three years' time, and that the 30 per cent., in addition to the then value of the lines, would only apply to small portions of the line. Accordingly, the whole matter was referred to the committee again. The Council having resolved not to consent to the Penarth Electric Tramways Syndicate's scheme, the company replied informing the Council that they thoroughly approved of the proposed tramways in Corporation-road, Clare-road, and Wood-street being constructed, and if necessary being maintained by the Council, the syndicate entering into an agreement for the use only of the same on terms to be mutually arranged. A discussion took place on the question, and the resolution refusing leave was referred back to the committee for further consideration. The Lighting Committee have requested the borough engineer to report on the probable cost of lighting all the lanes with electricity. Mr. Applebee (superintendent electrical engineer) reported that up to November 30 12,909-c.p. lamps were connected, compared with 7,732 at the same date in 1895, and no fewer than 1,200 lamps were now awaiting connection. During the past

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month the total number of Board of Trade units developed was 49,888, and the estimated revenue was £690. 4s. 1½d. private supply, and £78 public arc lights.

PROVISIONAL PATENTS, 1896.

DECEMBER 5.

27776. Improvements in or connected with the obtainment of metals or alloys by electrolysis or hydro-electro-chemical action. Pascal Marino, 47, Lincoln's-inn fields, London.

27809. Improvements in electric safety fuses. Morton Blencowe Cotterell and Hubert Russell, 13, Lanier-road, Lewisham.

DECEMBER 7.

27812. An improved electric battery. Eduard Saarburger, 11, Southampton-buildings, Chancery-lane, London.

27877. Improvements in or relating to electricity meters. George Hookham, 18, Southampton-buildings, Chancery-lane, London.

27903. Improvements in electrical glow lamps. Paul Scharf, 28, Southampton-buildings, Chancery-lane, London.

DECEMBER 8.

27992. Improvements in and with reference to electrical cable couplings by means of an insulating and locking arrangement. Michael Culligan, 1, Belgrave-square, Rathmines, co. Dublin.

28017. Improvements in and relating to electric lamps for cycles and the like. Thomas Gidley Howden, 46, Lincoln's-inn fields, London.

28043. An improvement in secondary voltaic batteries. Edward Maurice Grant, 28, Southampton-buildings, Chancery-lane, London.

28061. An improved electric current or pressure regulating device. Richard Holsten, 6, Lord-street, Liverpool.

28062. An improved device for regulating the distance apart of freshly inserted carbons in arc lamps. Richard Holsten, 6, Lord-street, Liverpool.

28070. Improvements in electric cables particularly suitable for telephone circuits. Frederick Hawkins, 111, Hatton-garden, London.

28101. Improved means for lighting by electricity and incandescence. John Archibald Sinclair, 191, Fleet-street, London.

DECEMBER 9.

28158. Improvements in ammeters. Siemens Bros. and Co., Limited, and John Nabel, 28, Southampton-buildings, Chancery-lane, London.

28193. Improvements in the caps of incandescent electric lamps. Edgar Julius Sander and Arthur Clifford, 22, Southampton-buildings, Chancery-lane, London.

28196. Improvements relating to dynamo-electric machines with motors for driving the same. Arthur Fischer and Adolf Held, 18, Buckingham-street, Strand, London. (Complete specification.)

DECEMBER 10.

28249. Improvements in or relating to terminals and other similar parts of electric conductors or apparatus. John Henry Kerridge, 111, Hatton-garden, London.

28267. Improvements in apparatus for measuring electricity. Edward Howard Percy Humphreys, 55, Chancery-lane, London.

28288. Improvements in anodes for the electro-deposition of nickel. Thomas Richard Canning, 4, South-street, Finsbury, London.

DECEMBER 11.

28314. Improvements in electrical storage batteries and cells. Rankin Kennedy, 33 Gladstone-street, Bradford.

28315. Improvements in controlling gear for variable speeds for mechanically and electrically propelled vehicles. Rankin Kennedy, 33, Gladstone-street, Bradford.

28347. Improvements in ceiling roses for electrical purposes. William Paul Theerman, 12, Corporation-street, Manchester.

28355. Improvements in connecting flexible wires to terminals for sundry electrical purposes. William Henry Lane, "Perugia," Sidney road, Staines, Middlesex.

28367. Improvements in electric arc lamps. Emil Hungerbuhler and Alfred Slatter, 433, Strand, London.

28392. Improvements in the method of and means or apparatus for actuating gas-valves controlled by the aid of electrical energy. Frederick Richard Boardman, 55, Chancery-lane, London.

28400. Improvements in and relating to electric motors. William Phillips Thompson, 322, High Holborn, London. (Julien Dulait, Belgium.)

DECEMBER 12.

28434. Improvements in electric tramways and apparatus therefor. James Enright, 202, Holland-road, Kensington.

28442. Improvements in regulating transformers. Manchester Edison-Swan Company, Limited, Alfred Still, and Edward Woodrowe Cowan, Victoria-street, Manchester.

28443. Improvements in high-tension electric fusible cut-outs. Manchester Edison-Swan Company, Limited, Alfred Still, and Edward Woodrowe Cowan, Victoria-street, Manchester.

28488. Improvements in or relating to electric arc lamps. Thomas Spencer and Christian J. Toerring, jun., 111, Hatton garden, London. (Complete specification.)

28511. Improvements in the manufacture of electric accumulators or secondary batteries. Lorenz Lucas, 4, South-street, Finsbury, London.

SPECIFICATIONS PUBLISHED.

1895.

22150. Electric indicators for bells, telephones, alarms, and the like. Walton.

23111. Electric incandescent lamps. Joel and Fanta.

23462. Striking and regulating mechanism of arc lamps. Coteworth.

1896.

64a. Electric tramways. Krizik. (Date claimed under Patents Rule 19, January 1, 1896.)

868. Electric meters. Raab.

968. Electro-deposition of metals. Graham.

1457. Incandescence electric lamps. Stearn. (Topham.)

10429 Holders for electric glow lamps. Kenny.

14015 Electric heating devices. Dymond. (The Chemisch Elektrische Fabrik "Prometheus" Gesellschaft mit beschrankler Haftung.)

16404 Electrical signalling apparatus or bells. Jevons and Collins.

18786. System of control for electric motors. Lake. (Sperry.)

26981. Production, regulation, and utilisation of electric currents of high frequency and apparatus therefor. Lake. (Tesla.)

21293. Electrical door bolts. Page.

23291. Trolleys for overhead systems of electric traction. The British Thomson-Houston Company, Limited. (Bassett.)

23315. Electrical apparatus for controlling traffic on single lines of railway. O'Donnell. (Hopkins.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	7⅞-8⅛
Brush Company, Ordinary	3	⅞-1⅛
—— Non. Cum., 6 per cent. Pref.	2	1-1¼
—— 4½ per cent. Debenture Stock	100	110-113
—— 4½ per cent. 2nd Debenture Stock	100	96-100
Central London Railway, Ordinary	10	9¾-10¼
——	4	3⅞-4⅛
Charing Cross and Strand	5	9½-9¾
Chelsea Electricity Company	5	8¼-8¾
—— 4½ per cent. Debentures	100	114-117
City of London, Ordinary	10	15¾-16¼
—— 6 per cent. Cumulative Pref.	10	16¾-17¼
—— 5 per cent. Debenture Stock	100	128-133
City and South London Railway, Consolidated Ordinary	100	53-55
—— 4 per cent. Debenture Stock	100	136-138
—— 5 per cent. Pref. Shares	10	15¼-15¾
County of London and Brush Provincial Co., Ordinary	10	8-9
—— 6 per cent. Cum. Pref.	10	13¾-14¼
—— 4½ per cent. 2nd Debenture Stock	5	7¾-8¼
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1¾-2¼
—— 5 per cent. Debentures	—	95-100
Edison and Swan United Ordinary	3	1¾-2¼
—— 5 per cent. Debentures	5	3-4
—— 4½ per cent. Debentures	100	103-106
Electric Construction, Limited	2	1⅜-1⅝
—— 7 per cent. Cumulative Pref.	2	2½-3
Elmore's Copper Depositing	2	½-¾
Elmore's Wire Company	2	¼-½
W. T. Henley's Telegraph Works, Ordinary	10	17¾-18¼
—— 7 per cent. Preference	10	18¾-19¼
—— 4½ per cent. Debentures	100	109-114
House-to-House Company, Ordinary	5	4½-5
—— 7 per cent. Preference	5	8½-9
India Rubber and Gutta Percha Works	10	20½-21½
—— 4½ per cent. Debentures	100	105-108
Kensington and Knightsbridge Ordinary	5	10-10½
—— 6 per cent. Pref.	5	8¼-8¾
London Electric Supply	5	1-1½
Metropolitan Electric Supply	10	13-14
—— 4½ per cent. First Mortgage Debenture Stock	100	121-124
National Telephone, Ordinary	5	7-7½
—— 6 per cent. Cum. First Pref.	10	17-19
—— 6 per cent. Cum. Second Pref.	10	17-19
—— 5 per cent. Non. Cum. Third Pref.	5	6⅜-6⅞
—— 3½ per cent. Deb. Stock	100	105-108
Notting Hill Company	10	10-11
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8½-9
—— £4½ shares	4½	7½-8
Oriental Telephone and Electric Company	1	11/16-13/10
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	103-105
Southampton Electric Company	5	4¾-5¼
St. James's and Pall Mall, Ordinary	5	12-13
—— 7 per cent. Pref.	5	9½-10½
Telegraph Construction and Maintenance	12	39-42
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	6	7¾-8¼
Westminster Electric Supply, Ordinary	5	11-12
Yorkshire House-to-House	5	7½-8

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NOTES.

Forthcoming Event.—Prof. Silvanus P. Thompson's first Christmas lecture at the Royal Institution, on Dec. 29, at 3 p.m.

Society of Arts.—Mr. C. T. Dent's lectures to children on "The Growth of Mountains" are fixed for the evenings of January 6 and 13.

Municipal Electrical Association.—This association will hold a meeting at the Westminster Palace Hotel, London, on Thursday, January 28, to consider the subject of "Fire Risks at Electricity Works." Mr. Pearson, of Bristol, will read a paper.

The Pacific Cable Conference.—The delegates to the Pacific Cable Conference have done something at last—they have done taking evidence. They have now to consider their report, but at present the meetings are adjourned for the Christmas holidays.

A Capillary Tube Phenomenon.—It would appear from a contribution of Mr. Schutt to *Wiedemann's Annalen* that if a current is forced to pass along the air at ordinary pressure contained in a very fine capillary tube, a very brilliant light is produced. The phenomenon seems to be explicable in more than one way, and it is significant that the inner surface of the tube is rapidly destroyed by the process.

Obituary.—We hear with regret of the death of Mr. William Moir, A.I.E.E., which took place on the 12th inst., after an illness of some months' duration. Mr. Moir was formerly of Callender's Cable Company, and latterly with Anderson and Munro, of Glasgow.—The death has also been announced of Mr. John Galloway, vice-chairman of Messrs. Galloway and Co., the engineers and boiler-makers, of Manchester.

Rontgen Rays and Blindness.—The loose talk, often ascribed to people who ought to know better, which has prevailed in America on the subject of overcoming blindness by the Röntgen rays has induced the superintendent of the School for the Blind at Philadelphia to test the matter with two blind students. Of course, the results were negative As usual, there is the exasperating neglect to mention which of the many forms of blindness were tried, but one would appear to be a case of cataract or some form of lenticular disease.

Magnetism and E.M.F.—As has been already noted, experiments have been made by Messrs. Lala and Fournier which, from the results communicated to the *Comptes Rendus*, would show that the E.M.F. of an iron-copper couple may be reduced in certain cases by a very considerable fraction of its total value if the couple is placed in a strong magnetic field. It would also appear from work by the same investigators that the E.M.F. of a copper-iron galvanic couple is reduced in a similar manner when the iron is strongly magnetised. The result is more than curious, as the effect ought to be very small.

Kromskop. — This is the name of the instrument embodying Mr. Ives's contribution to the problem of colour photography. It has no special concern for electricians, and it is simply introduced here to point a protest against the depths of ugliness and bad taste as to nomenclature into which so many designers of new apparatus permit themselves to fall. There really seems no possible excuse for adopting this illiterate variant of chromatoscope instead of the correct form. When we first saw the word we took it for South African Dutch, and puzzled our memories to know what it could mean.

Crystal Palace.—The certificates awarded by the examiners for the winter term examination to the students of the Crystal Palace Company's School of Practical Engineering were distributed on Friday by Mr. J. F. Flannery, M.P. Among those present were Mr. J. W. Wilson, principal of the school, and Mr. G. T. Rait, chairman of the Crystal Palace Company. Mr. W. T. Harbord was recommended for the medal of the School of Art, Science, and Literature, and certificates of honour were awarded to Mr. P. W. Tolhurst and Mr. N. W. Brushfield.

The Academie.—At the annual meeting at Paris, on Monday, of the French Academy of Sciences one of the two Arago medals was awarded to Lord Kelvin in honour of the recent jubilee of his professorship at Glasgow. Mr. Cornu, the president, spoke in glowing terms of the recent celebration at Glasgow. Mr. D. Abadie, the Abyssinian explorer, received the other Arago medal, and a prize was awarded to Prince Henry of Orleans for his explorations. Mr. Cornu, in an address on the Röntgen rays, dwelt on the "brilliant experiments" of Mr. Crookes 20 years ago, the lustre of which had been rekindled by the new researches of Lenard and Röntgen.

Condensers.—Mr. H. V. Carpenter, in connection with Mr. E. W. Poole, has been making an experimental study of the "soaking in" of a charge into solid dielectrics. Three condensers were used. In one the dielectric was mica, in the second paraffin, and the third had a very thin dielectric of a composition not ascertained. As published in the *Physical Review*, the results arrived at by the authors are that the "absorption" varies more rapidly than the thickness of the condenser and differs with different dielectrics. The curves and results obtained are interesting, but the data are hardly sufficient to warrant the setting out at greater length the conclusions arrived at upon the general question.

Scottish Engineers.—We have received the December number of the *Transactions* of the Institution of Engineers and Shipbuilders in Scotland. It contains the discussion on Mr. Morton's paper ("Steam") and Mr. Sinclair Couper's paper on "Internal Corrosion in Steam-Boilers." In reference to the former we could wish Mr. Stromeyer or Mr. Morton would not turn their T's and *t*'s topsy-turvy. Mr. Couper doubts the theory of the galvanic action of zinc used in marine boilers to prevent corrosion of the iron, although the zinc rapidly wastes away. His reason for doing so is that the pins or hangers supporting the zinc plate usually corrode at or near the point of contact. It is, however, rather a complicated matter.

New Cell.—The Sicard and Falle element consists of a zinc vase containing within it the positive, which is a cylinder of carbon containing a mixture of sulphate and zinc, potash alum, sulphuric acid, and bichromate of potassium. The cylinder is held in its place by being packed with sawdust, or some similar material, which fills the intervening space between the zinc and the carbon, and this is soaked with a solution of common salt. The E.M.F. is said to be over two volts. This seems high, but it should be said that the inventors do not claim for the cell anything more than that it is a convenient one for bells and that sort of thing. The inventors have also arranged the same combination in a rather better way on the lines of an ordinary cell.

Hertzian Waves in Water.—We have been favoured with the full text of Prof. D. Mazzotto's paper communicated to the Accademia dei Lincei on the subject of a redetermination of the index of refraction of water for electric waves. We hope as soon as time and space permit to give an abstract of the paper, but at present can

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only briefly note that Prof. Mazzotto's final value of the index of refraction for about 9in. waves (26 centimetres) is 9·0. It has, of course, been known for some years that for waves of this length the refractive index of water was very great compared with the index for light waves, but whether it will be found that the matter has a practical significance when it is attempted to carry on wireless telegraphy through a heavy rainstorm remains to be seen.

Accumulator-Making.—It is suggested by *Electron* (Madrid) that of all electrical industries the making of accumulators is the one for which Spain is most suited. Apparently because there is lead in that country. But it seems that accumulator-making is no light work to undertake. "The industry in question requires for its working, not only material money capital, so to say, but also and even principally the intellectual capital derived from a profound knowledge of chemistry and its applications to electricity, and a conscientious study of the very varied applications of the electric fluid." After that it is satisfactory to learn from our contemporary that they have got at Manzanares a factory which makes an accumulator which is superior to all other storage batteries. Unfortunately, the particular construction of this cell is not given.

Tramway Signalling.—Mr. Adolph Garing, of Carlstadt, New Jersey, has invented and patented an apparatus designed to prevent head collisions on trolley and other tramways. The invention consists principally of an electromagnet at each end of a section and a signal-carrying circuit wire leading from each magnet to the other end of the section, to connect with a ground contact point adapted to be closed by the armature of the electromagnet at the end of the section, the current passing through the circuit wires containing the signals being controlled by a part carried by the car. The signal boxes are designed to have each a night signal in the shape of a red electric lamp and a day signal in the shape of targets having "safety" or "danger" positions. But no one wants any more wires to bury, contact arrangements to get out of order, or posts to erect in the streets.

The Polytechnic.—This is the season of prize distributions, and our readers would hardly thank us if we embarked on the task of giving even a short notice of them all. But a reference may be made to the distribution of the prizes to the engineering and architectural students at the parent of all polytechnics, the Regent-street building, on Tuesday by Mr. Alfred Waterhouse. Mr. Buckmaster mentioned the architectural defects of the Polytechnic, and Mr. Hibbert declared that Mr. Ruskin had compared an architect to an accumulator. (But then Mr. Ruskin did not know what in the world an accumulator was, and would not learn—should it not be a transformer.) Mr. Waterhouse, however, assented, so it is to be presumed that the architects do not mind. Then there was music and "living photographs," including the motorcart race from Paris to Marseilles.

Round and Round.—By way of saving expense, the plan has been tried on the electric railway and elsewhere of not issuing tickets to the lowest class. This does very well in England, but it appears that in North Britain it will not operate. The Glasgow subway railway on its opening tried to run without tickets, but on the opening day it was found the passengers would not leave the cars, and numbers travelled round and round for one penny, preventing others from getting in. The subway railway has been closed on account of an accident. When it reopens this week tickets are to be introduced. There are legends of countrymen and others going round and round on our own Inner Circle here in London, but even the railway official with the chance of "excessing" has never supposed anyone would do it on purpose. Our ideas of an enjoyable ride appear to differ from those which prevail in Glasgow.

The Birkbeck Institution. — Mr. Frederick E. Boughton, who was for upwards of 20 years intimately connected with the Birkbeck Institution, died about a month ago after a few days' illness. Mr. Boughton some years ago had contracted heavy liabilities, in part on behalf of others; but by great efforts and many sacrifices on his part these have been very considerably reduced, and in a few years longer the measures he was taking would have discharged them completely. But his death has cut short these efforts, and the provision he had made for his family by life insurance will be entirely absorbed in discharging the remaining obligations. Under these circumstances an appeal has been made to students and friends and a committee formed, with Mr. H. Wells Eames as secretary, for the purpose of receiving subscriptions. Mr. Boughton was demonstrator in experimental physics at the Birkbeck for nearly 10 years, and since 1884 was the head of the physics department.

The Musical Taste of the Telephone.—The phonograph and the telephone are such modern finish-the-nineteenth-century kind of affairs, that no one would suspect them of a predilection for old-fashioned ways. Yet, so far as musical instruments are concerned, that is the case, for while with the phonograph and telephone a completely satisfactory reproduction of pianoforte music is usually difficult, it appears that the harpsichord is reproduced beautifully. Mr. Arnold Dolmetsch, who is an enthusiast in the matter of that instrument, says the reason is that because the tone of it is more musical. The philistine physicist will probably suggest that the character of the natural sound of the telephone disc has more in common with the tinkle of the harpsichord (or of a musical box) than of the sound of the hammered piano wire. The telephone has often a nasty way of transmitting noises which are anything but musical. That would account for it transmitting the blow of the pianoforte hammer too strongly.

International Code Telegrams.—At a special meeting of the principal code owners in Liverpool who do business with the Continent, convened to decide what reply should be made to the Postmaster-General's request that code owners should supply, free of any charge, copies of their codes to the Director of the Berne International Telegraph Office, with a view to the inclusion of as many words as admissible in the revised edition of the official vocabulary, it was resolved that there were objections to acceding to this request, as much of the contents of these codes are of a private character, the meanings being attached therein to the words taken from code dictionaries. A letter to this effect was accordingly despatched to the General Post Office. Of course, if the words used are taken from "admitted" dictionaries, it does not matter whether the codes are sent to Berne or not. But there can be no doubt that the proposed regulations as to code telegrams are not viewed without a certain amount of mistrust in business circles.

Yorkshire College Engineering Society.—At the ordinary meeting of the members of this society last week at Leeds, Mr. H. McLaren (the president) in the chair, a paper on the "Utilisation of Multiphase Currents in Electric Driving" was read by Mr. Percy Nicholls, of Manchester. The lecturer explained the principle of the three-phase motor, and remarked that with a three-phase generator no return line was necessary, as in the case of a

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single-phase alternator (three wires instead of two). Another advantage was that they required very little attention, and ran for days together without being touched, the automatic lubrication being very perfect. By means of a small switch the motor could be run in either direction, and resistances could be used to vary the speed. By the use of the lantern and screen the lecturer showed the most recent types of three-phase motors of both English and foreign make, and referred to the well-known Frankfort power transmission line. A discussion followed, in which Messrs. McLaren, Sykes, Towler, Darley, and Cornock took part.

Motorcarts.—It has always seemed probable that there was a fine potentiality of pyrotechnic display about the benzine motorcart; but two of them have shown that they have the true artistic spirit in selecting a wide stage and a good audience for the show. One chose the Boulevard Haussmann, in Paris, last week, and the time five o'clock—*i.e.*, just dark. The flames shot up above the second floors of the houses. The French firemen, of course, tried to put out burning benzoline with water. Number two was in Oxford-street earlier in the afternoon, and from a spectacular point of view not nearly so exciting. But it amused the crowd, and showed what could be done in the way of enlivening our streets. A really malicious machine would have selected a congested part of the Strand or a narrow street in the City to burn in, as then there would have been at least an off-chance of setting fire to something and a fair certainty of frightening someone into running under a horse's hoofs. A gentleman has been fined for obstruction in the City with a motorcar. It was left in charge of a man for 20 minutes, but no one knew how to move it so as to let the traffic pass.

Induction Telegraphy.—The following is a letter from Mr. J. F. Young, of Llanelly, to the *Western Mail*, which we give as it stands: "Seeing your report of Mr. Preece's above experiment in to-day's paper reminded me of a similar experiment made by Mr. MacLucas and myself 18 years ago. We constructed an original arrangement by which we could communicate with each other. Mr. Lucas was living in Vaughan-street and I in Stepney-street. This we did without wires, and it so far succeeded that we could not only converse with each other, but we could hear each other's watches tick, and other sounds, such as people walking about the room, piano-playing, etc. Referring to what Mr. Preece said about induction, it may interest some of your readers that although the post office was two doors away from my dwelling, messages sent by the postal authorities could be easily read in my house. This was also due to induction. The postal authorities should take this hint, and prevent, if possible, such an occurrence." Even at the end of 1878 the telephone and microphone were quite new discoveries, and everyone was much interested in trying experiments.

The Channel Islands.—There is a paper in Guernsey called *Le Bailliage* which appears to change its mind whether it shall print in French or English about three times a column. To us inhabitants of the larger island, who for the last 400 years or so have given up speaking the language of our conquerors, it looks strange. But that is not the point. What is, is that *Le Bailliage* has published a long article from a correspondent urging the adoption of electric lighting. In Jersey it has been adopted "in principle"; but unless the Guernsey people are altered, that will hardly be an argument in its favour unless they could get their lamps alight before Jersey. The interesting point, however, and one to be borne in mind in preparing schemes, is under what regulations will the lighting be carried out. The extension of an English Act to the Channel Islands depends upon a technical formality which may or may not have been complied with. And even if the English rules hold, nothing is clearer than the fact that the local legislature can make any additional or even conflicting ones that it chooses. And if they do not agree, both must be complied with. Even the National Telephone Company cannot do exactly as it chooses in Guernsey.

Affixed to the Freehold.—Those who have read their leading cases will remember that even when Elwes *v.* Mawe was argued there was already question of the limits of a landlord's right to confiscate another man's engine on the plea that it is affixed to the freehold. But the matter is not settled yet. In the Court of Appeal on Saturday, before the Lord Chief Justice and Lords Justices Lindley and A. L. Smith, judgment was given in an appeal, Hobson *v.* Gorringe, from a decision of Mr. Justice Kekewich. The question involved was as to the right of the vendor, under a hire and purchase agreement of a gas-engine which he had allowed the purchaser to affix to his land, to recover possession thereof, on the failure of the purchaser to pay the stipulated instalments, as against a mortgagee in possession of the land. Mr. Justice Kekewich decided in favour of the defendant, the mortgagee in possession, and their Lordships, holding that as a fixture the gas-engine had ceased to be a chattel and had become a part of the freehold, affirmed this decision, and dismissed the appeal with costs. As there would be some difficulty in passing a gas-engine as a trade fixture, which by custom "as to which the memory of man runneth not to the contrary" had been always removable, the matter is worth the attention of all leaseholders hesitating between setting up a supply installation for themselves or taking current from the mains.

Electrolytic Work.—According to a review of the progress of electro-chemistry which has appeared in the *Elektrotechnischer Anzeiger*, hydrogen is manufactured electrolytically at the Leopoldshall works, compressed, and sold in steel cylinders in the usual way. *L'Electricien* has suggested that gas produced in this way might be used for gas-engines. There seems to be a regardlessness of expense about the proposition. The electric production of ozone does not seem to have made very much practical progress, although there have been a number of arrangements for that purpose brought out. The reduction of phosphorus by means of the electric furnace is stated to have made considerable advance during the past year. The phosphorus manufacture is, however, a very close business. Lately, Siemens and Halske, at Vienna, are stated to have succeeded in producing commercially by electrolytic methods antimony of very great purity. As to carbon there has, of course, been any amount of work done in the electric furnace, but the processes take place at such an exceedingly high temperature, and under circumstances in which exact measurement is so difficult, that it is usually impossible to say whether the effect is purely a heat reaction or whether electrolytic action has anything to do with it. It may be added that by treating in this way a mixture of powdered rock crystal and powdered carbon, not only the nearly colourless crystals of silicon carbide have been obtained, but also black crystals of silicon. A commercial use, however, has yet to be found for the latter.

The Davy-Faraday Laboratory.—Magnificence, in the Aristotelian meaning of the word, is by no means an obvious virtue, and there are abundant examples to show that it is easier to become a millionaire than to spend the acquired wealth in a really well-seeming manner. Dr. Mond, whose munificent gift to the Royal Institution was opened on Tuesday by the Prince of

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Wales, of course, knows the crying need for research in pure chemistry and physics; but it would be well if some of the public benefactors who do not could be brought to see the advantage of departing from the common lines. We have already briefly described the new laboratory. Of the opening there is little to say. Dr. Mond made an interesting speech, to which the Prince of Wales returned a graceful reply, remarking on the fact that Dr. Mond had given to the new research laboratory the names of Davy and Faraday instead of his own. (There are larger works than any laboratory to perpetuate the name of Mond), and with the formal opening this country was able to advance the unique claim of possessing the only public laboratory in the world solely devoted to research in pure science. Of course, almost everyone was there that could be, and among others noticed were the Duke of Teck, Earl Percy, Lord Halsbury, Lord Playfair, Lord Ashbourne, Lord Knutsford, Lord Rothschild, Lord Kelvin, Lord Rayleigh, Lord Belhaven and Stenton, Sir Frederick Abel, Sir John Lubbock, Sir Henry Roscoe, Sir George Stokes, Sir James Blyth, Sir John Brunner, Sir Douglas Galton, Sir John Donnelly, Sir Benjamin Baker, Sir Frederick Bramwell, Dr. Huggins, Dr. Anderson, Dr. Hopkinson, Mr. W. H. Preece, Mr. Alexander Siemens. Mr. W. Crookes, and Mr. J. W. Swan. A series of experiments with liquid air were afterwards exhibited by Prof. Dewar.

The Telephone and Competition.—We have no means of ascertaining by experiment the effect of competition on the telephone in England. Nor will looking abroad help, for foreigners and Englishmen are not alike in all their ways. If we may say so, however, without offending them, there is not so very much difference between American men of business and our own as to prevent us looking across the Atlantic to see what is thought there on the subject. It is a country of "pools" and trusts, and they know all about monopolies there. Mr. Fred de Land, of *Electrical Engineering*, however, is definitely of opinion that competition in the telephone service is decidedly no good to the competing company. He has prepared a list of 24 towns where competition has been tried and failed—few of them very big ones, however. But except that he makes no reference to the effect of the liability to competition in keeping the Bell Company up to the mark, Mr. de Land may speak in his own words without further comment: "At first thought it appears perfectly feasible to make a competing telephone exchange profitable property, yielding good returns on the investment, and during the first few months nearly all competing exchanges flourish in a financial sense. For the unhealthy public sympathy stimulated for selfish ends enables town councils to grant franchises containing very liberal provisions, while the interest taken by many citizens ensures a large number of subscribers from the start. But though opened under the most favourable auspices, yet the records show that gradually one competing exchange after another suspends operations, and the plant is sold for what it will bring—often for old junk—unless the franchise is a peculiarly liberal one. The cause is easily found. The closed exchanges at Waukesha, at Topeka, at Fort Smith, at Selma, and at twenty other points all tell the same tale: 'Inability to secure an income from low rates that would warrant the expenditure necessary to secure the talent requisite to maintain and operate the plant in a manner that would ensure prompt and efficient telephone service.' This truthful and official statement is the whole story in a sentence. Nowhere was any legal action taken by the Bell Company, though in everyone of these exchanges apparatus was used that no doubt infringed patent rights owned or controlled by the Bell interests. But everywhere the Bell service formed the standard by which the new service was measured, and the expectations that a telephone service far superior to the Bell would be supplied at half the rates formerly charged were never realised. And when the quality of the service continued to depreciate, one after another of the subscribers refused to continue renting the new instruments, and the end soon came. Then the doors were closed, the plant sold for what it would bring, usually about one-fifth or one-tenth of its cost, and the original investment proved a total loss."

Liquid Oxygen.—We are indebted to the authors for a copy of Prof. Fleming and Prof. Dewar's paper on the dielectric constants of liquid oxygen and air which was read last week before the Royal Society. The authors in their experiments used a small condenser (capacity ·001 microfarad) made of 17 aluminium plates, kept apart by fragments of glass at the corners of the plates. This condenser was charged in liquid oxygen and in air, and afterwards discharged a given number of times in succession into a larger condenser for measurement. The reduction of the observations taken in this way presents some points of interest, but cannot be summarised here. As to possible leakage, it is known that liquid oxygen is a very perfect insulator, and it was also found that at the low temperature of just evaporated oxygen or air the ordinary leakage of an air condenser was immensely reduced. The construction of the condenser made it necessary to determine whether the specific inductive capacity of glass is changed at -182 centigrade, and hence we have incidentally the interesting result determined that the dielectric constant of crown glass is reduced by 21 per cent., of paraffined paper 28 per cent., but of mica only about 3 per cent. by cooling to that temperature. Further work in this direction is to be undertaken. As a result of measurements made with the condenser described above, the authors find the dielectric constant for liquid oxygen at -182 centigrade and standard pressure to be 1·49. There is a small uncertainty depending on the variation of the constant for gaseous oxygen or air as the temperature falls to -182, but it is practically certain that this would only affect the third decimal place. From similar experiments in liquid air all that can be said is that K comes out slightly higher, as during the experiments, of course, the nitrogen was evaporating away, leaving the mixture at the end practically oxygen only. The value 1·49 is very low, which is in accordance with the general rule that a high resistance in a dielectric goes with a low constant, and *vice versâ* (Nature cannot suit all). Profs. Dewar and Fleming have just recently determined the magnetic permeability (p) of liquid oxygen at 1·00287. Now, according to the electromagnetic theory of light, Kp should equal the square of the refractive index for exceedingly long waves of the luminiferous medium. The refractive index of liquid oxygen has been determined by Profs. Liveing and Dewar for several lines in the visible spectrum; but extrapolation according to a not very well-established law is necessary to obtain the limiting value for the infinite wave. The result, however, comes out right within 1 per cent. It may further be added that on Prof. Dewar's determination of the density of liquid oxygen as 1·14 and the permeability given above, the magnetic susceptibility of oxygen in the liquid state is nearly twice that of an equal mass of the gas, from which it is inferred that magnetic susceptibility is not merely a property of the molecule *per se*, but is a function of the state of aggregation.

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RAILWAY BLOCK SIGNALLING.

BY J. PIGG.

(Concluded from page 693.)

Electrical methods have also been suggested for this purpose. Some of these involved the use of a bell fixed on the engine in any convenient position. This bell was to be operated by a battery, also carried on the engine, the circuit being closed by an obstruction placed by the side of the line, which was operated by simple means in conjunction with the signal to be indicated. This arrangement was not reliable on account of the difficulty experienced in maintaining batteries in a state of efficiency under the conditions of their use, and also on account of the vibrations and shocks to which the apparatus was subject.

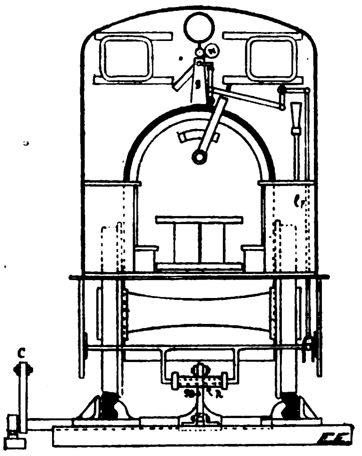

Fig. 102.

Other arrangements involved the use of a large bell, fixed in proximity to the line at a suitable height, which was intended to ring continuously whilst the signal was "on," and which could be put out of operation when not required by the use of a small peg switch. Such arrangements are of little use for the purpose intended; the difficulty of conveying sounds from the outside to the inside of the cab of an engine in rapid motion are immense, and can only be appreciated after experience.

Suggestions have also been made for repeating the position of the signal arm directly on the engine by mechanical means, worked in conjunction with the signal. One of these methods is shown by Figs. 102 and 103. The apparatus on the engine for indicating the positions of signals consisted of a small fac-simile of the ordinary outdoor signals. This was fixed in the cab of the engine, as shown. A counterbalance, W, was fixed to the arm so that when not otherwise supported the latter took up the "on" position. To the frame of the engine was pivoted a metallic rectangle, R, arranged to turn on its upper side as an axis. A rod, bifurcated at its lower end to engage with pins, *p*, on the rectangle, R, passed then to *s*, and supported the arm in the "off" position under normal conditions. Movement of the rectangle in either direction caused the support to be withdrawn from the arm of *s*, and it at once took up the "on" position by the action of the counterbalance. As will be noticed from Fig. 102, the arm could

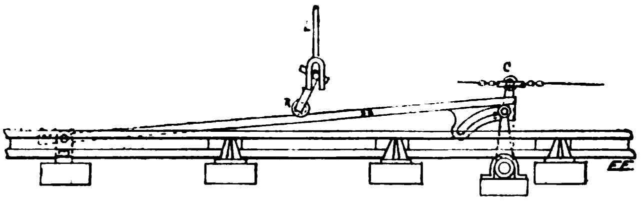

Fig. 103.

only be replaced in the "off" position by the direct action of the driver.

The great difficulty in connection with the design of apparatus for this purpose is the violent shock experienced when used on trains travelling at a high rate of speed. In order to minimise the shock, the swinging rectangle, R, was operated by sliding over the inclined bar, B (Fig. 103), which was fixed in the centre of the 4ft. way, and one end of which was raised or lowered as the signal was "on" or "off." When the signal arm was "off" it was, of course, intended that the bar, B, should be in such a position as would prevent its operating upon the swinging rectangle, R.

The fixing of such a means of operating an indicator on the engine requires considerable care if placed in the 4ft.

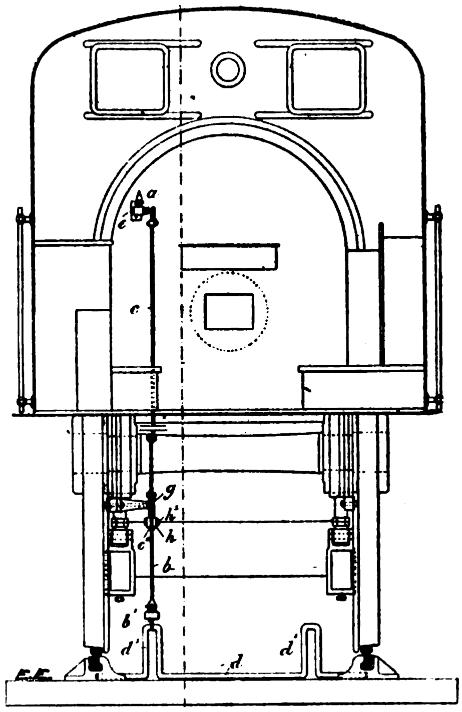

Fig. 104.

way, on account of the small amount of space available. The bar, B, when inclined for use, must project above the rail level; since the space between the rail is often filled up at level crossings the swinging rectangle must necessarily be set high enough to miss all such points. On the other hand, the bar must not be of such a height as to come in contact with the engine firebox, or any of the

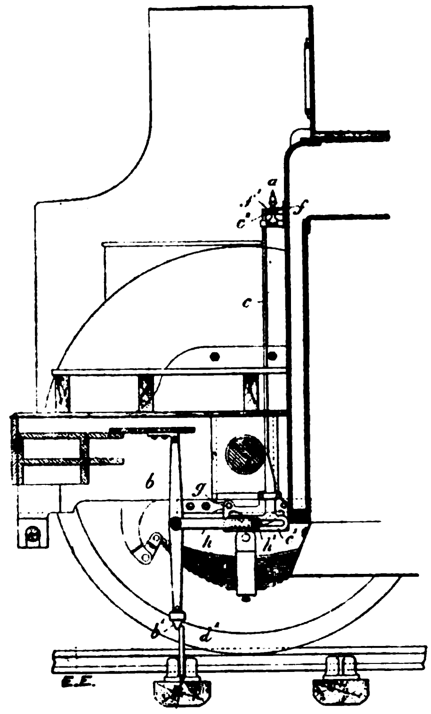

Fig. 105.

mechanism. Of course, it is possible to place such apparatus on the outside of the rails, but as engines do not always run engine first, it would be necessary to provide bars on both sides of each line of rails, or as an alternative provide attachments on each side of the engine.

A similar apparatus, patented by Messrs. Raven and Baister, of Darlington, is at present under trial on the North-Eastern Railway Company's lines. This arrangement

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is shown by Figs. 104 and 105. The main principle is the operation of a special alarm on the engine, when the latter is approaching or passing a signal at danger. In this form, however, the alarm takes the form of a special whistle, which may be operated by steam or compressed air. The valve controlling admission of steam or air to the whistle is operated by the movement of the pendulum levers, *b*, when the latter come in contact with the raised obstructions. The lever, L, which is connected to the pendulum levers carries a pin which works in the straight slot, C^1, formed on the lower end of the rod, C, and also works in the curved slot formed on the fixed plate, *g*. Movement of the pendulum, *b*, causes the pin to rise in the fixed curve slot and raises C^1 and C, and opens the valve. It will be interesting to note the progress made in this development of automatic signalling, as, from the remarks made, the necessity for some such method is increasing. One of the greatest advantages arising from the use of such methods as those just described is due to the fact that they are in continual use, and, therefore, require no special arrangements to be made, and involve no additional operations on the part of any person concerned, to contribute towards the results desired.

Closely connected with this part of the subject is the question of repeating the positions of the mechanical signals in the cabins from which they are operated. The relative importance of the "on" and "off" indications has already been referred to. It only remains to point out that confining repetition to "distant" signals which are out of sight of the signalman is not consistent. The general rule is to repeat a signal which, even under normal conditions, is not visible to the signalman; and as "distant" signals are more frequently out of sight than any other, repetition is confined almost solely to this class of signal. Bearing in mind the real reason for repetition, it follows that any signal which may, under any circumstances, be out of sight of the signalman should be similarly treated. Very slight consideration is necessary to show the advisability of repeating all signals: during fog or snowstorms, distant signals, which under normal conditions are in plain sight, are quite invisible, as also are "advance" and "home" signals in particularly bad cases. As fogmen depend entirely upon the position of the signal arm for their guidance, it becomes of double importance that the signalman should have an accurate knowledge of their positions under these circumstances. For these and similar reasons, the increased use of repeaters of the positions of the mechanical signal arms seems desirable; and, as already pointed out, the repetition should be that of the arm itself, and not that of some point on apparatus more or less intimately connected with the arm.

Another point of great importance may be shortly referred to. This is the need for an uniform system. At present nearly every railway company's system differs from those of other companies, in either the regulations or the apparatus employed, or both. For this diversity of method or apparatus no really valid reasons can be alleged. The handling of railway traffic is practically the same wherever carried on, and the fact that block working, wherever used, is, in its essential characteristic—the enforcement of a space limit—uniform, is proof that uniformity of means to the end is merely a matter of arrangement. The end in view in all cases is exactly the same, and there is no reason to suppose that, generally, any one of the ways taken is speedier or smoother than the others. On the other hand, the advantages accruing from uniformity of code and apparatus would be considerable, and would put into the hands of railway companies powers which, under certain conditions, would be of the greatest importance, but which they do not yet appear to appreciate. Unfortunately, the amount of capital already invested in existing apparatus precludes the idea of a speedy reformation in this respect.

It may be thought that in giving so much attention to non-electrical methods, such as traffic arrangements and the mechanical signalling of trains, the writer has, to use a familiar colloquialism, "got off the rails." The term "block system" is too frequently used to indicate the electrical portion of the apparatus only. It cannot, however, be too strongly emphasised that the signalling which acts in *notification* of the movements of the trains, and only indirectly controls those movements, and that through another medium, is not the *whole* of the "block system." The term "block system," as the writer understands it, has a much broader significance, and consists in the preservation of a space limit between the successive trains, the means used to effect this desirable end being of importance only in proportion to the degree of perfection attained in producing that effect. The recognition of the necessity for a space limit is as old as railways themselves, and the methods of the present period are simply developments, rendered necessary by continual increase of traffic, along a line which has been rigidly marked out by a continual process of trial and error. In just the same way that the weakest link must be taken into account in gauging the strength of a chain, the whole of the apparatus connected with the working of traffic must be passed under review, before its combined efficiency can be fully estimated. No part can stand alone. Careful traffic arrangement is necessary to ensure that smooth and speedy working which is the first essential of all successful work. Electrical signalling is necessary for the preliminary arrangements required to marshal traffic in the order of its importance, to facilitate its passage with safety, and to notify its progress. Mechanical signalling is the executive of both.

MALTA ELECTRICITY SUPPLY.

The electricity supply works which have been undertaken by the Government of Malta commenced supplying current on December 1, 1896. They are interesting to engineers and members of local authorities in that the Government have not only provided machinery and mains for supplying private consumers, but have dispensed at the outset with gas lighting in the public streets and squares, for which they have substituted incandescence and arc lamps. The electricity works are equipped with machinery capable of giving a total output of 375 kilowatts, and of this the public lighting alone requires 124 kilowatts. So with private consumers, among whom are the Governor's palace and several of the War Department buildings, the works may be considered to have started with a paying load.

When contemplating taking up electric lighting the Government consulted Mr. W. H. Preece, C.B., F.R.S., and he, assisted by his son, Mr. A. H. Preece, drew up the scheme upon which tenders were invited. Of the tenders sent in that of the Brush Electrical Engineering Company was found to be the most advantageous for the whole of the work, and was accordingly accepted. The distribution of electricity is effected by low-tension alternating currents. Transformers fed by high-tension feeders running from the generating station to various points in the towns supply this low-tension system. This arrangement was adopted, in the first place, because it gives absolute safety to the users of the current, and, secondly, because it is possible to send the current through long feeders with but a small loss of power.

The area supplied at Malta is very scattered, the longest feeder being that to the Three Cities, a distance of 5,000 yards from the generating station to the first chamber. The towns of Valetta and Floriana being intersected throughout with subways, advantage was taken to lay the cables in them as far as possible. The generating station is situated on the Marina adjoining the custom house, and comprises an engine-room, 109ft. by 26ft., and a boiler and condenser room 109ft. by 25ft. Excellent coal-stores and water-tanks are also provided, and there is ample room for extensions in the present building. The work of arranging the building has been in the hands of Mr. Gatt, C.E., the Government engineer. The following detailed description of the works may be of interest:

Boilers.—Steam is supplied to the first instalment of plant from three Babcock and Wilcox water-tube boilers, each capable of evaporating 6,000lb. of water per hour at a working pressure of 150lb. per square inch. The heating surface of each is 1,827 square feet, and the grate area 33½ square feet. The drums are 48in. in diameter by 23ft. 7in. long, and are each provided with two safety-valves, one non-return steam-valve, one steam stop valve,

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duplicate feed and check valves, and all the latest improvements in water-gauges, etc. A steam soot-cleaning apparatus is fitted to each boiler, by means of which sooty deposits are blown off the tubes. A ladder and gangway across the top of the boiler is provided, and the brickwork fronts are finished off with buff and white glazed bricks. The firing is at present done by hand.

Steam and Exhaust Pipes.—The main steam-pipe, which is of wrought iron, 6in. diameter, is in the ring form, with valves so arranged that any portion of the ring may be easily isolated without interfering with the working of the engines. Copper expansion bends are employed where necessary. All the valves used are of the parallel slide type. Water separators are provided in the main steam-ring, as well as on each engine, which are drained by Geipel's patent steam-traps. The exhaust-piping, which is of cast iron, ranges from 12in. diameter downwards, is arranged to either open into the condenser or direct to atmosphere, as may be desired. There is an automatic relief valve on the pipe which opens the exhaust to the atmosphere in the event of stoppage of the condensing plant, and there is also a valve for shutting off the condenser when required. All the steam-piping is covered with magnesia sectional non-conducting covering.

Feeding Arrangements.—There is one duplex feed pump, 6in. by 4in. by 6in. stroke, and two injectors (one spare), each capable of delivering 3,000 gallons of water per hour. They are arranged to supply the boilers direct from the town mains or from a galvanised wrought-iron tank, the latter being heated by the exhaust steam from the feed pump. The feed pipes, which are of galvanised wrought iron, are also on the ring system, with suitable valves for isolating any section, and this piping is also covered with magnesia sectional non-conducting material.

Condensing Plant.—The exhaust steam is condensed by a Ledward patent ejector condenser capable of dealing with 600 i.h.p. The cooling-water, which is obtained from the sea, is supplied by two centrifugal pumps, each capable of delivering 35,000 gallons of water per hour, one being coupled direct to the shaft of the Brush 6in. by 5in. vertical engine, the other being driven by means of belting from an alternate-current motor. The pumps are fitted with gun-metal discs and manganese bronze spindles, and each has an air-ejector for charging with water before starting up. A Mordey-Victoria transformer, 2,000 to 100 volts, supplies current to the motor, and there is a switchboard with ammeter and high and low tension switches and fuses for controlling it. The cooling-water is taken from a deep sump into which the sea-water flows, and the discharge is also to the sea. The condensing-water pipes are all 7in. in diameter, and of cast iron. A non-return valve and strainer are fitted to the suction, and suitable sluice-valves are placed where required.

Main Engines.—There are five main engines, three being of 166 i.h.p., and having cylinders 11½in. by 20in. by 12in. stroke, and running at 231 revolutions per minute; one of 84 i.h.p., with cylinder 8½in. by 15in. by 8½in. stroke, and running at 273 revolutions per minute; and one of 40 i.h.p., with cylinder 7½in. by 12½in. by 7in. stroke, and running at 300 revolutions per minute. The high-pressure cylinders are provided with piston-valves and the low-pressure with ordinary slide-valves. Steam is controlled by highly sensitive flywheel governors, and Hackworth gear is provided for varying the low-pressure cut-off whilst running. Raworth patent flexible couplings are used for coupling the engines direct to their respective alternators.

Alternators.—There are five alternators of the well-known Mordey-Victoria type. Three of them have an output of 100 kilowatts each, and the other two 50 and 25 kilowatts respectively. The armatures are stationary, as usual in this type, while the field magnets revolve. They generate current at a pressure of 2,000 volts. These alternators work in parallel with each other irrespective of size. The lubrication is automatic, being effected by small pumps which keep up a constant circulation of oil.

Exciting Plant.—The exciters, four in number, consist of two compound-wound Brush-Falcon two-pole dynamos, each having an output of 12,000 watts and coupled direct to Brush compound tandem engines 6in. by 10in. by 8in. stroke, upon one bedplate; and two small exciters are coupled directly to the 50 and 25 kilowatt alternator shafts, so that the day-load plants have each their own exciter. The 12-kilowatt exciters are each capable of exciting all the alternators running at one time, so that ample provision is made as regards safety and meeting both full and day load requirements economically.

Switchboard. — The main switchboard consists of the following separate slate panels: two for exciters, one synchroniser, five alternators, and six circuits, mounted together in a handsome polished teak frame and standing in one corner of the engine-room upon a raised platform. Two sets of omnibus bars are arranged at the back of the board so that any alternator can be put either singly or in parallel on either set of omnibus bars. The high-tension switches throughout are of the Brush quick-action trigger type, with mechanical make and releasing gear, and the high-tension fuses are of the Bate's pattern enclosed in porcelain handles. The low-tension switches are of the Brush chopper type. Suitable measuring instruments are provided on each panel, and the whole station is regulated by the rheostats which control the exciters. Each alternator is also provided with a resistance for compensating the change in resistance in the field circuits due to temperature variations. There are two small panels (placed underneath the 50 and 25 kilowatt alternator panels) containing instruments, switches and fuses, and regulating resistances for the two small direct-coupled exciters. Ample provision has been made on the board for extensions.

Crane.—The engine-room is spanned by a 10-ton travelling crane, with hoisting, cross travelling, and longitudinal travelling motions, all worked by hand ropes from the floor level. For light loads up to five tons the return block may be removed and the single chain used, the free end being provided with a five-ton swivel hook.

Distribution.—The current is carried from the generating station on the Marina to Valetta, Floriana, and Three Cities by means of concentric high-tension feeders, supplied by the British Insulated Wire Company. These are insulated with specially treated paper, lead covered and armoured and laid direct in the ground, or drawn through the numerous subways which exist throughout Valetta and Floriana. These feeders have a section of ·1 square inch as far as the Three Cities—a distance of 5,000 yards—·065 to Valetta, and ·035 to Floriana, and terminate at the principal sub-chambers. From thence high-tension distributors, insulated and protected in a similar way to the feeders, but varying in size from $^7/_{14}$ to $^7/_{20}$ in size, are taken to the sub-chambers, which are placed at convenient centres for distribution. Special high-tension isolating switches, enclosed in cast-iron boxes, are fixed at convenient points, and Geipel patent high-tension joint-boxes are used for jointing; the joints being mechanical are easily made, and may be inspected by removing the cover. Each high-tension feeder contains specially insulated pilot wires, and these are connected through highly insulated plugs to an electrostatic voltmeter on the main switchboard, thus enabling the station attendant to readily ascertain the pressure at the feeding points. The low-tension distributing mains consist of ·180, ·154, and ·077 square inch concentric cables insulated with specially prepared paper, lead covered, and armoured with steel, similar to the high-tension feeders. The house service connections are made with vulcanised rubber concentric cable drawn through galvanised wrought-iron pipes. The joints are made with Geipel patent joint-boxes, and the cable terminates in the Brush Company's specially designed lock-up cast-iron switch fuse-box fixed on the consumer's premises.

Transformers.—These are placed in sub-chambers cut out of the solid rock, or in War Department or public buildings. At present there are 40 transformers in use, varying from the 18-kilowatt size down to two-kilowatt. They are of the Mordey-Victoria type enclosed in cast-iron watertight cases, and provided with earthed shields between the primary and secondary coils. Current is transformed from 2,000 volts primary to 210 or 105 volts on the secondary, and, besides the primary switches and fuses contained in the transformer-case, switches are also provided in cast-iron boxes and inserted between the high-pressure supply and the transformer. Gabled top joint-boxes connect the high-

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pressure mains to the transformers, and each box is provided with connectors for three transformers. Low-tension switch fuses and gunmetal omnibus bars convey the current from the low-pressure side to the circuits.

Public Arc Lighting.—The first instalment consists of 60 arc lamps, 45 of which are placed round the Grand Harbour and the remainder in the Palace-square and Strada Reale. All with the exception of two suspended from brackets are fitted into frames mounted upon cast-iron posts designed and made by the Brush Company at their Falcon Works. The lamps are of the Brush-Vienna 15-ampere alternate-current type arranged to burn 16 hours without retrimming. The above lamps are worked off a separate main, the conductors consisting of concentric cables insulated with vulcanised indiarubber, taped and braided and drawn into galvanised iron pipes. These mains are connected to small transformers which transform from 2,000 to 35 volts, the latter being specially designed to fit the lamp-post bases. Switches are provided to each lamp, and impedance coils are not required with this design of transformer. The cable runs from post to post and connects into specially designed terminals on the transformer. Thus all jointing is avoided and the cables may be quickly disconnected for testing or other purposes. Having each its own transformer, the lamps have therefore been provided each with an independent supply; any one can be turned on and off without in any way interfering with the supply to the remainder, or the whole may be switched on and off by the main switch.

Public Incandescence Street-Lighting.—Gas has been superseded throughout the whole of the streets of Valetta, Floriana, and the Three Cities by 770 32-c.p. incandescent lamps, either fitted into globe fittings with reflectors and attached to brackets, or where practicable fixed into the existing gas lanterns. These lamps are grouped in sections, and are worked off separate circuits, the conductors consisting of single cable, insulated with vulcanised indiarubber, taped and braided and laid upon insulators in the subways, and lead-covered twin vulcanised rubber cables laid in chases out of the solid rock where subways do not exist. In all cases the conductor is led up to the lamp through wrought-iron tubing fixed to the wall of the buildings, suitable fuses being inserted in watertight cast-iron boxes immediately underneath the lamp bracket. The various sections are supplied by transformers from sub-chambers specially provided for this part of the work. The distributing circuits conveying the low-pressure current to the lamps are taken from specially designed fuseboards mounted in cast-iron watertight cases. There are 16 brackets fitted to eight of the arc lamp-posts; these lamps are controlled by special switches, one operation putting in either the arcs or incandescence lamps as desired. The voltage of these incandescent lamps is 37, current being taken from the arc lamp transformers; the others are run at 100 and 103 volts.

General.—The whole of this important work has been supplied and erected by the Brush Company, while the general supervision has been entrusted by the Government to their consulting engineers, Mr. W. H. Preece, C.B., F.R.S., and Mr. A. H. Preece (who have been assisted by Mr. Marcus Chambers), and Mr. L. Gatt, the Government engineer at Malta. The general design and equipment of the works has been in charge of the Brush Company's contract department, under the control of Mr. W. Geipel, M.I.E.E., their superintending engineer, assisted by Mr. A. Mahood as resident engineer.

ON THE MANUFACTURE OF ALKALI AND BLEACH BY CHEMICAL AND ELECTROLYTICAL METHODS.*

BY BERTRAM BLOUNT, F.I.C., F.C.S., A.M.I.C.E.

(Concluded from page 665.)

A good word may be said for the use of mercury as an intermediate electrode and carrier of the products of electrolysis, in that it removes the need for a porous septum, and appears in practice, as in theory, to undergo no sensible loss or depreciation. Again, the anode is a standing obstacle. In almost all cases carbon is used, the particular form of that substance known as retort carbon being preferred. But even this very dense and refractory form of carbon is not wholly unaffected, and anodes made therefrom can only be considered as semi-permanent portions of the plant. There are, it is to be feared, no reliable data as to the life when in constant work of an electrolytic cell for the production of alkali and bleach. One must be content with qualitative statements. Nevertheless, it is well to recognise that it is not sufficient in computing the cost of an electrolytic process to reckon a capital expenditure, and to calculate on that the usual charges for interest and depreciation; a portion of the plant—viz., the diaphragms and anodes—should have a specially high rate of depreciation charged upon them, if, indeed, they might not rather be reckoned as part of the current expenditure, just as so much oil and waste would be.

At this stage of the paper, it appears not without value to transcribe certain calculations of cost of decomposing chlorides of the alkali metals electrolytically made by the well-known German electro-chemist, Dr. Borchers, and published recently in the *Zeitschrift für Elektrochemie*. He takes in the first place the cost of an electrical horse-power for the year, working day and night, at £4 when water power is available, and at £8. 15s. to £20 when coal has to be used. This corresponds with about 0·09d. and 0·24d. to 0·55d. per horse-power hour. It is probable that the cost of water power is here underestimated, and in any case it is not of primary importance in this district. The lower value for steam power may be accepted as a basis for calculation. Each electrical horse-power year, working with theoretical current efficiency but with a voltage of four volts (of which more anon), will decompose 3·5 tons of salt, having a value of about £2. 15s., and will produce 2·4 tons of caustic soda, worth £19, and rather over two tons of chlorine, which, as chloride of lime, is worth £35. The production of the latter material involves the consumption of 3·2 tons of lime, costing £2. 8s. Therefore from raw materials costing in all £5. 3s., and by the expenditure of power costing £8. 15s., products can be obtained having a market value of £54. An outlay of £13. 18s. to gain £40. 2s. is certainly tempting to the speculator. Making a similar comparison for some of the best-known processes proposed or put in practice in this country, values are obtained which, if not quite so attractive, at least offer a large enough margin for profit. Thus the Castner-Kellner process is credited by its devisers with a current efficiency of 88 to 90 per cent., so that assuming it can be worked at the same pressure as that chosen above (four volts), and taking the same buying and selling prices for the raw materials, and the products, chloride of lime and caustic soda, the expenditure will be £13. 5s. and the net profit £35. In the case of the Hargreaves-Bird process the preference of the patentees is for the manufacture of sodium carbonate rather than for that of caustic soda, and the estimates have to be modified accordingly. The current efficiency claimed is 80 per cent., and the pressure said to be required is 3·4 volts. Accepting these, an expenditure for raw materials and power of £13. 12s. yields a profit on the sale of the finished products (soda ash and bleach) of £39. 9s.

Others could no doubt be quoted giving on paper profits almost equally seductive. That such profits have hitherto proved hard to realise is due to the causes already indicated in an earlier part of this paper—viz., the high cost of the plant per unit of output and its considerable deterioration in use. Another cause may be touched on here. It must not be supposed that both chief products of electrolysis, caustic soda and chlorine, separate neatly and completely from the electrolyte in which they have been formed. Their combination, with the production of salts of various acids containing chlorine and oxygen, is apt to occur if the diaphragm be in any degree too porous, or if electrolysis be pushed so far that the liquid in the cathode compartment is even moderately rich in caustic soda. The inconvenience of allowing the liquid in the anode compartment to remain saturated with chlorine can scarcely be avoided, as the only practicable means of prevention—viz., keeping the electrolyte hot—is not to be thought of on other grounds altogether. When once saturation has occurred, however, the further quantity of chlorine evolved escapes spontaneously, and can be sent direct to the bleaching-powder chambers. But with the caustic soda a definite method of recovery is needful. According to the practice generally adopted in most processes, brine is circulated through the anode and cathode compartments independently, and fresh salt added as the strength of the liquor declines.

It may be taken that the most concentrated solution of caustic soda that can be profitably prepared in an electrolytic cell contains not more than 10 per cent. of the solid substance NaOH. With this is associated a large quantity of undecomposed salt, and the recovery of the latter is a necessary concomitant of the isolation of the former. Fortunately, the majority of sodium salts are insoluble in a concentrated solution of caustic soda, whence it happens that on boiling down a weak solution, separation of sodium chloride takes place progressively, and the separated salt can be fished out. There should be no serious difficulty in ultimately preparing caustic

* Paper read before the Northern Society of Electrical Engineers, December 7, 1896.

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soda containing no greater quantity of foreign salts than does the best grade of caustic soda now put on the market—viz., that known as "77 per cent.," which is approximately pure NaOH. It is true that a considerable quantity of caustic soda will cling to the salts fished out, but this is only a source of loss in so far as it represents a certain amount of marketable material locked up in the process, and necessitates the addition of a small sum in the reckoning of interest on the whole stock. The caustic soda held in this way is not lost, but returns with the recovered salt to the cathode compartments. Processes such as the Castner-Kellner, using mercury as an intermediate electrode, have the advantage of obtaining caustic soda in solution free from salt, and the necessity for separation does not arise.

I have said nothing as to the production from fused salt of chlorine and sodium (and caustic soda from the latter by the action of water) because the mechanical difficulties of constructing an apparatus capable of withstanding the attack of sodium chloride at a red heat have hitherto proved of the most formidable kind, and although gallantly encountered both in this country and abroad have, as far as I know, not yet been overcome. It is enough to say here that any process of the sort will always be handicapped by two circumstances—(1) the necessity for supplying energy in some form to keep the electrolyte fused, and (2) the waste occasioned by the need for expending energy sufficient to win sodium itself instead of caustic soda, that balance of energy being wasted as heat when the sodium is brought into contact with water for the production of caustic.

Any review of the subject of the electrolytic production of alkali and bleach would be imperfect without a section devoted to the consideration of the merits of the plan of manufacturing caustic potash in place of caustic soda. Suppose it be conceded to those who deny that the formation of caustic soda electrolytically is likely to be profitable, that the prospects of success are not altogether assured, it may at least be possible to contend that a better fate attends the manufacture of caustic potash. Happening as it does that potassium is less widely and abundantly distributed in the earth's crust than is sodium, and that certain compounds of potassium cannot be industrially replaced by sodium, it follows that the price of potassium salts is higher than that of corresponding sodium salts, and is likely to continue so. Gunpowder is still a primary necessity of civilisation, or, perhaps, one should say, a standing need of peoples not yet initiated in the mysterious charms of smokeless explosives, and its manufacture is carried out on a large scale. Again, it is clear that a period of national rejoicing cannot be celebrated in a convincing manner without the aid of the artist in pyrotechny. To what sorry plight would both be reduced if denied the use of potassium nitrate and chlorate? In all seriousness there are many considerable manufactures—of which the preparation of soft soap and of oxalic acid may be mentioned—in which the use of potash, as distinct from soda, is a *sine quâ non*. How with a valuable raw material, such as potassium chloride, the cost of the energy and labour impressed upon it is a smaller fraction of the whole cost of the finished product than is that of the energy and labour spent upon a cheaper material—*e.g.*, sodium chloride. Losses of the raw material at any stage of its conversion consequently have a greater monetary significance, and a process operating cleanly and in a manner economical of the material handled will have an advantage which may outweigh any extra expenditure of energy. An estimate similar to those already quoted is available for the case in which potassium chloride instead of sodium chloride is electrolysed. Using the same data as before and assuming a theoretical current efficiency and a voltage of four volts, one electrical horse-power year would produce from 4·4 tons of potassium chloride and 3·2 tons of lime, 3·3 tons of KOH and 5·2 tons of chloride of lime. The cost of the power is £8. 15s., that of the potassium chloride at £7 per ton is £31, and that of lime £2. 8s., while the value of the products, reckoning caustic potash at £26 per ton, and chloride of lime at £6. 15s., is £86 and £35 respectively, representing a gain of £79 on an expenditure of £42. Of this expenditure the fraction which has to be incurred in buying raw materials by any process whatever is fourth-fifths, so that it is obvious at a glance that economy of raw material is of greater importance than in cheapness of handling. Translating these figures into something which is not beyond practical attainment—*i.e.*, assuming a current efficiency of 80 per cent., and using, as before, a voltage of four volts, an expenditure for raw materials and power of £35 would yield products representing a gain in value of £62. Of the expenditure, the fraction representing the cost of the raw materials is three-fourths, so that the position is almost as favourable as when the theoretical current efficiency is assumed.

Perhaps the most promising of all processes for preparing by electrolysis one of the products of the alkali trade is that for the manufacture of potassium chlorate. The apparent simplicity of the requisite reactions is most enticing. On electrolysing a solution of potassium chloride, caustic potash and chlorine are to be expected as the first products. If then no attempt be made to separate these products, but, on the contrary, the cell be provided with a good agitator, they will unite to form potassium hypochlorite if the solution be cold, and potassium chlorate if it be hot, according to the equation

$$6KOH + 6Cl = KClO_3 + 5KCl + 3H_2O,$$

five-sixths of the total potassium concerned in the reaction reverting to the condition of chloride. It must not be supposed that this reversion represents an avoidable waste; the chlorine which, for clearness of argument, may be regarded as liberated in the first stage of the electrolysis, is fully represented by oxygen in the ultimate product—potassium chlorate. In existing chemical processes the reaction between chlorine and an alkaline substance is carried out with lime instead of potash. and potassium chlorate is prepared by double decomposition with potassium chloride. Therefore, under these conditions, five-sixths of the chlorine is actually run away as calcium chloride—another example of the typical defect of most chemical processes—viz., the production of a large quantity of almost worthless by-product. It is difficult to say how far the manufacture of potassium chlorate by electrolytic means is carried on at the present time. Somewhat florid accounts occasionally reach us from the Continent and the United States, but thoroughly reliable information cannot be readily obtained. The manufacture has either failed to attract attention in this country, or possibly is being quietly pursued with a profit which would shrink if competing makers were aware of its successful working.

There are certain general considerations on which it may not be superfluous to insist in summing up the present position of the manufacture of alkali and bleach by chemical methods and by electrolysis. In the first place, it is customary and necessary to state the current efficiency of a process—that is, the output of the desired product as compared with that calculated from the ampere-hours. This is desirable, because the efficiency of the cell in keeping separate the products of electrolysis and of allowing of their isolation in a marketable form is thus ascertained, irrespective of all questions of internal resistance. But the efficiency thus stated is not the energy efficiency of the cell. A cell with a given current efficiency may be working at a pressure of three, four, five, or six volts, and the energy efficiency of the last will be just half that of the first, in spite of an identical current efficiency. The total number of heat units represented by the conversion of a given raw material into given products under known conditions can be calculated from existing thermo-chemical data with a fair degree of precision; the total number of units of electrical energy passing with a known current at a known voltage can be stated with accuracy; the number of units of electrical quantity concerned with the fulfilment of a given reaction is also known; the minimum voltage which will accomplish the decomposition can therefore be calculated fairly closely. Thus when sodium chloride in solution is converted into gaseous chlorine and caustic soda in solution, about 53 cal. are required for one gramme equivalent of NaCl. The smallest pressure at which electrolysis can be effected is therefore 2·3 volts. But the lowest voltage yet claimed for any process producing caustic soda and chlorine is four volts, whence we see that an electrolytic method needing this voltage and having a current efficiency of 80 per cent. has an energy efficiency of only 46 per cent. I do not say that full efficiency can be readily attained, but I do say without hesitation that it is above all things requisite to keep the calculated limit steadily before us both in judging or comparing processes and in seeking to devise improvements on such methods as exist. It is well to realise—and a considerable amount of iteration in enforcing it may consequently be pardoned—that there is a margin of some 50 per cent. at the disposal of the electro-chemist intent on improving extant processes for the industrial decomposition of common salt. This possibility has been overlooked or intentionally ignored by those concerned with the exploitation of particular processes and not unnaturally anxious to put the most favourable construction possible on the performance of their pet cell, but the attitude of mind thus induced is about as reasonable as that of the copper smelter who prefers the old and inaccurate Cornish dry assay to exact modern methods of analysis because the former deals lightly with the imperfections of the smelting process, not to mention his own technical shortcomings.

A precise quantitative comparison of the merits of the chemical and electrolytical methods of preparing alkali and bleach is obviously impossible at the present time; were it possible, every maker would be using one or the other, and the *raison d'être* of this paper wouid disappear. But it is practicable to sum up the weak and strong points of the two processes in a qualitative sense. The electrolytic process is direct, cleanly, economical of labour, free from worthless by-products. *Per contra*, its units of plant are small, troublesome, costly, and quickly deteriorated by use. The chemical process can provide a large output with comparatively few units of plant, of, on the whole, simple construction and of large size; repairs, though heavy, are not numerous, nor have they to be applied to a vast number of small apparatus. On the other hand, much arduous and fairly skilled labour is requisite, and by-products valueless or of negative value are invariable concomitants.

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FREE WIRING.

One objection that a struggling tradesman has to introducing the electric light is that the gas fittings already installed and paid for become useless. He has to pay a lump sum to a contractor for wiring his premises, for his fittings, and his lamps. The cost of installing the electric light, so far as his business books are concerned, is the value of the gas fittings discarded in addition to his payment to the contractor. Many men find it inconvenient to make such payments in a lump sum, while they would for many reasons be glad to change their system of lighting. In order to meet this difficulty some corporations and companies have arranged a system of free wiring, increasing the charge per unit of electrical energy consumed in order to recoup the initial outlay and interest thereon. We are rather disposed to agree with a system of free wiring, providing the charge for the same is not too one-sided. It is impossible to discuss a large number of special cases, but we may take as an average a small business premises consuming 35 to 40 units a year with, say, 20 16-c.p. lamps. The revenue from such a customer would at the highest consumption be only between 10s. and 11s. per 16-c.p. lamp per annum. Take the cost of wiring at a pound per lamp, or a total of £20. If, now, the corporation or company charge ½d. or ¾d. per unit extra, the revenue will be 1s. 8d. or 2s. 6d. per lamp; or in the one case 8⅓ per cent. on the outlay, in the other case 12½ per cent. on the outlay. Corporations can easily borrow money at 3 per cent., so that business of this kind would amply repay them. But is such a return just to the consumer? We think not, and should expect to see corporations at any rate putting a limit of time upon the extra charge per unit. If they got an 8 per cent. return upon the expenditure, a part of that return should be used to pay interest upon the capital borrowed, and the remainder used as a sinking fund to repay the capital. When such repayment was completed the customer ought no longer to be charged the extra amount. A system such as we have sketched out would be just to both parties. The customer would be benefited in that his payments for installing would be spread over a time, rather than being paid in the lump. The corporation would reap a large reward in that the output of the station would thereby be increased, and the larger the output the less the total cost. Further, in this particular a corporation is in a better position than a company, in that it can get its money cheaper; and properly managed, its expenses ought to be less, hence the extra charge would be as low as possible.

LIVERPOOL OVERHEAD RAILWAY.

The company owning the above railway is to be congratulated on the successful working of their system of electric traction and on the fact that they own the most remunerative electric railway in the kingdom. This is all the more gratifying when the nature of the traffic is considered. As our readers know, the line runs the full length of the Liverpool docks, with extensions to the suburbs at either end.

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These extensions will provide for a certain number of travellers on their way to and from home, but the bulk of the traffic is due to the docks themselves. The dock-labourer class is the largest customer, and the fares are fixed to suit the pockets of this class. Thus a penny fare will carry one from the centre of the line at the landing stage to either end or to any intermediate station. A twopenny fare is charged for travelling the full length of the line. This is over seven miles long, and the fact that profit is made by carrying passengers at little more than a farthing per mile reflects great credit on the management of the company and on their able engineer, Mr. S. B. Cottrell. The southern extension of this line was opened to the public on Monday last. The private inspection and the opening ceremony took place on the previous Saturday, and was attended by an influential gathering. The details of the difficulties to be overcome in this additional portion of the line and of the construction of the tunnels were given in Mr. Cottrell's paper before the British Association this year and printed in our issue of October 16. The extension links Liverpool to the districts of Dingle, St. Michael's, Prince's Park, Sefton Park, and Aigburth, and will be of great service to the residents of these suburbs. The station at the end of the extension is underground, and is lighted by arc lamps placed two in series on a 110-volt circuit, supplied by a motor generator from the power circuit. Sir W. B. Forwood, the chairman of the company, in proposing "Success to the Extension" after the lunch which was provided after the inspection of the line, said "that the electricity supplied from their own generating stations not only provided the motive power but the lighting, heating, and automatic signalling, and added that the great economy of its use had been a revelation to the directors. He believed that they would before long see electricity much more generally used by great railway systems, and that its use would greatly increase the efficiency of the lines and also greatly add to the returns to the shareholders." A five minutes' service will be given throughout the day, and there will also be an express service during the busy hours of the morning.

GAS.

It may interest some readers to know, says the *Contract Journal*, that 203 local authorities in Great Britain and Ireland own their gasworks. Of these, 160 are in England and Wales, 36 in Scotland, and seven in Ireland. Besides these, there are 437 private companies, of which two are in Scotland, nine in Ireland, the rest in England and Wales. The authorised capital of companies is £55,443,940; of local authorities, £28,966,927. Of these authorised amounts, the companies have paid-up capital amounting to £45,195,416, and the authorities have borrowed £25,624,326, showing a total capital spent £70,819,742. The receipts of the companies amount to £12,982,956, of the authorities £6,478,191, with respective expenditures of £9,491,344 and £4,881,944. The total coal used amounts to 11,937,446 tons, from which 121,421,752,691 cubic feet of gas is made, of which 111,443,701,941 cubic feet were sold during the year ending March 25, 1896. There were at that time 23,857 miles of mains, supplying 2,659,771 consumers' premises and 526,888 public lamps.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

BRISTOL TRAMWAYS.

SIR,—With reference to the editorial in your issue of the 18th inst. on the Bristol tramways, I would point out, as a fundamental difference between the Bristol tramways and the Dublin tramways, that in Dublin the line extends some eight miles away from the power-house and a further extension had to be considered, whereas in Bristol none of the lines proposed or contemplated extend from the proposed power station such a distance.

It has never been done or contended that the electricity at Dublin was as economically supplied to the cars as at Bristol; the Dublin system was designed purely to meet the conditions prescribed by the Board of Trade.—Yours, etc., H. F. PARSHALL.

London, E.C., December 18, 1896.

WHOM TO CREDIT?

SIR,—With reference to the article on the "Storage Battery at the Manchester Corporation Electric Light Works," which appeared in your issue of the 27th ultimo, it was mentioned that the battery was of the Chloride Company's well-known "R" type. It might interest some of your readers to know that this type of battery has only the negatives made according to the "Laurent-Cély" process, or chloride process, whereas the positives are made according to my patent of May, 1895, which involves a great improvement in the mechanical construction of Planté plates with composite grids. As it was only by the peculiar construction in question that the high discharge rates were made possible, I was surprised at my name being omitted in connection therewith by the author of your article.—Yours, etc., JOHN. RHODIN.

47, Victoria-buildings, Manchester, December 22, 1896.

[We do not acknowledge any remissions on our part in the description of this battery. It is absolutely impossible to credit the designer of every detail in every piece of work; if that is to be done, we shall have to find out the first designer of brass-headed nails, octagonal-headed screws, and so on. The battery described was that known to the trade as the "R" type of the Chloride Company. We have to credit the Chloride Company with the work, and cannot go behind their back.—ED. *E. E.*]

REVIEWS.

The Commercial Organisation of Factories. By J. SLATER LEWIS. E. and F. N. Spon.

The author in his preface laments the want of some system of accounts common to the factories throughout the country. Hence, as every firm has its own methods, there is no recognised system for a student to learn. The system of accounts in the book before us is put forward as one which might be generally adopted, and the author has spared no trouble in making the same clear to the reader. The organisation of the factory is even more important, and the hints as to the interdependent work of all the officials are most valuable. Nothing conduces more to the prosperity of a firm than a well-organised staff working concordantly together, but even such a staff without a good system of accounts cannot assure the financial success of the undertaking. The author reviews the division of labour in the management of a manu-

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facturer's business, and shows how essential it is that every man employed should be an expert in his individual work. This applies specially to the principal himself, who usually has the direction of the staff, and the idea that blustering about from one department to another is the correct way to control a large establishment is absurd. The coolness and self-possession recommended by the author must, however, be accompanied by a firm hand, and all decisions must be prompt and final.

Chapter VIII. deals with suppliers' orders and invoices, and contains many truisms with regard to the purchase of goods by tender. The acceptance of the lowest tender is advised in all cases, except when the strongest reasons exist for a departure from the custom. In this, however, so much depends on the character of the apparatus tendered for, and in engineering matters it frequently happens that the lowest-priced article is the dearest in the long run. The chapter on the drawing office is full of detail. We should, however, liked to have seen the question of the responsibility of the individual draughtsman, and also as to the final inspection of working drawings, taken up more fully. The practice of storing standard drawings in a fireproof safe is to be commended, but, failing this, the author advises that copies of the standard be given to a responsible person to take home. Here we differ strongly, and consider that neither standard drawings nor copies should ever be let out of the office or workshops. The question of estimating is so closely allied to that of accurate prime costing that the two must be considered together. Thus, in the book before us the cross references between the two chapters dealing with these subjects are very numerous. One difficulty in estimating lies in the fact that a good part of the cost of the finished article is that of establishment charges. These charges are fairly constant in amount, and hence the amount to be borne by each machine turned out varies very largely with the quantity of work in hand. Thus in a large firm, while the establishment charges become most burdensome at periods of slackness to vary the estimated prices for new work to meet those charges will serious handicap the firm in obtaining new orders. The author goes thoroughly into a system of book-keeping for these establishment charges, but admits that the results obtained are not sufficiently firm to warrant the clerical labours involved. It frequently happens that where a large firm competes with smaller houses there are certain articles produced by both which cannot bear their due proportion of the establishment charges of the large firm. Thus any rigid rule fails, and the special branch has to be fostered by a lowering of charges. The author strongly advocates the use of curves of prices both as a means of adjusting the values of various sizes, and also for ready reference. The irregular curves given, of different manufacturers' prices for low-tension dynamos show how much such a method is required. The author opens his chapter on pupils as follows: "It is the practice in many engineering establishments to take pupils for a term of years at premiums ranging from a small sum to a thousand pounds. This in itself is a perfectly legitimate practice, but with some firms these premiums constitute the bulk of their revenue. Such firms should be described as pupil farmers and not as engineers." The course for pupils is detailed and the difficulty of ensuring discipline amongst premium pupils is referred to. The author's plan for turning out good engineers is from this cause often made futile. As the volume consists of some 540 pages, we have hardly touched the fringe of the subject. In these pages the author has given a very large number of different forms to be filled in either by the engineering staff or accountant. The only objection to the number of these is the fact that all works managers and foremen have their time fully taken up, and cannot as a rule undertake more clerical work. Hence too large a number of forms are apt to defeat the object in view of carrying work through to time, and at the same time keeping a record for the accounts department. Still, the author has devoted great labour and forethought to the preparation of the book, and many of these forms are likely to be adopted. If there is one point more than another needing amendment we think that it is the fact that approximate figures are not given. Thus we should like to get some idea from the volume as to the relative cost of labour and standing charges in engineering works; also some figures as to general values to allow for depreciation on machine tools would be useful. That exact values cannot be given we know, but students gather a good deal from a statement of approximate values. On the whole we can recommend the book to all engineers interested in the financial standing of factories.

OPENING OF THE CHESTER ELECTRICITY WORKS.

The formal inauguration of the Chester electricity supply took place on Thursday, 17th inst. We gave a full description of the generating station, it will be remembered, in our last week's issue. A number of prominent officials, townsmen, and others were present, including, of course, the Mayor and Mayoress (Mr. and Mrs. B. C. Roberts), Prof. Kennedy, Mr. Thos. Parker, Mr. T. Browne, and Mr. I. Matthews Jones, the city surveyor.

The MAYOR, in his opening speech, congratulated the citizens of Chester upon having the installation at last complete. Touching upon the history of the undertaking, his Worship remarked that having obtained tenders for the installation, the Corporation, as business men, would have nothing to do with the acceptance of any one of the competitive schemes submitted, but determined to place the matter in the hands of the greatest authority in this country and the greatest living scientist—Lord Kelvin. Lord Kelvin drew up an exhaustive report, in which he strongly recommended the Corporation to adopt that of Messrs. Thos. Parker and Co., Limited. This advice was taken, as was also the suggestion of the same authority that Prof. Kennedy should be appointed to superintend the carrying out of the scheme. In concluding his speech, the Mayor introduced Prof. Kennedy, who then gave a popular explanation of the means by which the electricity supply was effected.

The Mayoress was then called upon to switch on the current, which was accomplished by simply bringing pressure to bear on a gold bracelet, presented by Mr. Thos. Parker. The switching on of the light was hailed by loud applause.

The MAYOR then declared the installation open, and also moved a vote of thanks to the consulting engineer (Prof. Kennedy) for his very able services to the Corporation.

Councillor C. J. JONES (deputy chairman of the Electric Lighting Committee) seconded the motion.

Prof. KENNEDY briefly replied.

A vote of thanks was also accorded to Messrs. Thos. Parker and Co., Limited, the contractors; Messrs. Clarke and Thursfield, the resident engineers on behalf of Prof. Kennedy and the contractors respectively; Messrs. J. H. Davies and Sons, the architects; Mr. Helms, the clerk of the works; and the various sub-contractors.

In the evening the Mayor's official banquet was held at the town hall, advantage being taken to make it commemorative of the introduction of the electric light into the city as well. The Council-chamber, in which the banquet took place, was beautifully illuminated for the occasion by means of the new illuminant. Mr. Rooper, of Stafford, the contractor for the wiring of the town hall and public market—whose name we inadvertently gave as Rupert in our last issue—was responsible for the special lighting arrangements.

In the speech-making subsequent to the banquet various mention was made of the electric lighting scheme which had only a few hours previously been formally inaugurated, and success to the undertaking was proposed by the Mayor, and heartily responded to.

Electric Machinery for Bridges.—The Chicago Rock Island and Pacific Railroad Company's new bridge across the Mississippi from Davenport, Iowa, to Rock Island, Illinois, is about completed. The new bridge, which replaces an old single-track structure built in 1872, is a double-track railroad and highway, with a total length of 1,850ft., including a draw span of 366ft. operated by electric power. The estimated cost of the bridge is about £100,000.

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HOW TO INCREASE THE WORKING EFFICIENCY OF RAILWAY MOTORS.*

BY WM. BAXTER, JUN.

The first workers in the electric railway field did not have as easy a task in the matter of designing motors as the engineers of the present time. Then electricity was endeavouring to obtain a foothold, so that it was necessary to meet the existing conditions and develop machines that would operate successfully under them, but in the course of a few years electricity obtained such mastery over the field that the designers were able to make such changes in the conditions as they found necessary to facilitate their work.

The old horse cars ran on 30in. wheels, and the under side of the body was not over 12in. above the centre of the axle, and in this space the motors must be placed. The speed of these cars was not over six miles per hour, and, while greater velocity was desired, anything over 14 or 15 miles would have been regarded as inadmissible. On account of these restrictions, the difficulty of designing a single-reduction motor was more than those engaged in the work could overcome, hence the double-reduction machines were resorted to.

As soon as the popularity of electricity became demonstrated, engineers began to study the subject with a view to devising a single-reduction motor of reasonable weight and size and capable of running at a velocity not greater than that of the double-reduction motors. As the problem was a difficult one, they did not meet with immediate success. In the meantime electricity was forging ahead so fast that it soon became evident that a single-reduction motor would be accepted, even if it were a great deal heavier and larger than the machines in use, and even if it ran at a much higher velocity, providing it would reduce the cost of repairs, and this it was very evident it would do by greatly reducing the wear of the gearing, which at that time was a formidable expense. Taking this view of the case, no doubt, the larger corporations brought out single-reduction motors, which from an engineering point were but little short of failures Their weight ranged from 3,000lb. to 3,500lb., and their size was such that they could not be used with safety on cars provided with 30in. wheels; and the speed was increased from about 14 to 20 or 22 miles per hour. Not only were the wheels increased from 30in. to 33in., but the car body was raised from 2in. to 3in. higher above the axle, and therefore the distance from the under side of the car to the track was increased from 27in. to about 31in. Notwithstanding the increase in size and weight, the cross-section of the field was so small that the torque was very much less for the same current than with the double-reduction machines.

By a series of steps the design has been improved, and as a result the modern motors are of a greatly reduced size and weight, in some cases weighing less than 1,500lb., but the size of car wheels still remains the same, and is indeed necessary, owing to the fact that the gears on the axle are larger than could be safely used with smaller wheels. The current consumption has not been reduced to any appreciable extent, saving in this direction having been sacrificed apparently to obtain reduction in weight. Some of the engineers engaged in this field justify this course by saying that current is about the cheapest thing around an electric railway plant, and that a few amperes more or less make very little difference. If this is sound reasoning, one must naturally wonder why so much money is spent in expensive compound and triple expansion engines, whose only advantage is that they reduce the cost of the output.

It is evident that a reduction in the current consumption is of the greatest importance, for it not only reduces the running expenses but also the first cost of the plant. If a saving of 20 per cent. in the average current consumption per car can be effected, the station and line capacity can be reduced to that extent, and the cost of this part of the plant would be no greater for a 100-car road than it now is for 80 cars.

Engineers who have never had experience in designing railway apparatus are very apt to believe that if the efficiency of the motors is high, any such saving as 20 per cent. is impossible; but this not the case, and it will be shown that it is not in the following paragraphs.

Some time ago a brief description of one of the latest motors brought out by the General Electric Company appeared in the columns of the *Electrical World.* Curves were given showing the horizontal effort, the speed, and the efficiency, and the latter was shown to be nearly as high as 83 per cent., with a current of 40 amperes to the car, and not lower than 74 per cent. within the ordinary working range. This efficiency is certainly very good, for it must be remembered that it includes the loss due to the friction of the gears and all other parts; but a study of the horizontal effort curve will show that the increase with increasing currents is not as great as it might be. As an illustration, take the efforts at 20, 40, and 80 amperes, which are, as near as can be judged from the curve 180, 350lb. and 1,380lb. respectively. Now, as the frictional loss is a greater percentage of the lower efforts than of the higher, the difference in the torques would not be as great as these figures, but would probably be 200, 600, and 1,500. If the field remained constant the torque would rise in direct proportion with the current, and owing to the reduced frictional loss the horizontal effort at 40 amperes would be more than double that of 20—that is, more than 360lb., probably 380lb. As at the low rate of magnetisation that must prevail with such a small current the greater part of the magnetising force is impressed upon the air-gap, the increase in the flux density should be nearly proportional to the increase in current, and therefore the effort at 40 amperes should be not far from four times as great as at 20. At 80 amperes the effort is about 1,380lb., which is not as great an increase in proportion as that between 180 and 550, but this is the natural result of the greater magnetic density. These figures indicate that the cross-section of the field is not as great as it should be to obtain the necessary flux with a low magnetising force, and that the deficiency in this direction is made up by an increase in the ampere-turns. It is believed by some that this principle of proportioning is the correct one, and in defence of it they point out the fact that if the cross-section is increased and the magnetising force is reduced the effect will be to cause the speed to drop too much when the current is increased, and they contend that it is better to use a little more current and keep up the velocity. If the difference in velocity were as great as the difference in current, and if all this difference could be made available, the argument would be a good one, but the gain in speed is effected at a very heavy current expenditure, and on this account motors having a large field cross-section and a sufficient number of turns on the armature to cut down the velocity with respect to the current, will run the car at very nearly the same speed against a given resistance, owing to the fact that the necessary effort can be obtained with less current—therefore the working velocity will not be reduced very much, but the current will. Furthermore, as the large-field motors can develop a greater torque with excessive currents, the rate of acceleration in starting will be greater, and time will be saved in this way. Adding to this the fact that running speed does not help much to increase the velocity through crowded streets, and that going down grade the fast-running cars cannot gain much as the velocity is such that the current is cut down to a point where the effect of it is slight, it must be evident that for the general run of city and suburban roads increased motor speed is of very little advantage in the way of enabling the cars to make better time from end to end of the road, and that its real effect is to considerably increase the current consumption.

Purely theoretical reasoning is seldom as convincing as an actual demonstration based upon practical results, therefore the writer may be pardoned for presenting in the following the operation of motors of his own design in which the principles above referred to were adopted.

The curves, 1, 2, and 3, in Fig. 1 show the horizontal effort, speed, and efficiency respectively of a car equipment of two motors. The dotted curves, 4, 5, and 6, give the corresponding data for the G. E.-1,000 motors just considered. The table gives the data of Fig. 1 more accurately than it can be obtained from the latter, and in addition to this the

* From the *Electrical World* (New York).

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electrical and effective horse-power. The field cross-section of these motors ranges from 695 square centimetres in the armature core to over 800 in the largest parts of the field proper. The air-gap area is about 1,100 square centimetres; length of magnetic circuit, 48cm.; turns on field, 200; turns on 1,015 equal 507 in series; air-gap, 6·4mm.

A comparison of Curves 3 and 6 will show that the difference in the efficiencies of the two types of motors is very slight, and that where the current runs from about 57 to 70 amperes the dotted curve is the higher. The difference in the horizontal effort curves, however, is very great. At 20, 40, and 80 amperes the figures are: 215lb., 765lb., and 2,480lb. for the solid line and 180lb., 550lb., and 1,380lb. for the dotted. The increase in the effort of the dotted line between 20 and 40 amperes is in about the ratio of 3 to 1 and for the solid line about 3·5 to 1. Between 40 and 80 amperes it is about 2·7 to 1 in the former case and 3·25 to 1 in the latter. In the dotted line curve the increase between 40 and 80 amperes is about 90 per cent. of what it is between 20 and 40, but in the solid curve it is 93 per cent. From this we can see that for the first doubling of the current the increase in horizontal effort is less in proportion in the dotted curve than in the solid one, and that in the second doubling it is still less. This shows that the magnetisation is higher for a given current with the motors represented by the dotted curve than it is in those represented by the solid line.

is due to the fact that the small cross-section fields with high magnetising force soon become magnetised to a point where the permeability is so low that the increase in magnetising force due to increase in current produces only a small change in the flux. On the other hand, the large field cross-section, with the same current, is magnetised to a lower density, owing to the reduced number of ampere-turns. This is clearly shown in Fig. 3, which gives in Curve 9 the density in the air-gap, and in Curve 10, that through the armature core.

Although the velocities with equal currents are widely different with the two types of motors, when the relation between speed and horizontal effort is looked into it will be found that the difference is very much less. This is shown in Fig. 2, in which Curve 7 gives the speeds corresponding to different efforts, for the large field-motors, and Curve 8 the same for the small-field. Here we see that with a horizontal effort of 400lb. the speed of the two motors is 14·6 and 16·8, but the current consumption is about 27 amperes for the slow-speed and 37 for the high. The difference in speed is about 15 per cent., and to obtain this the current is increased about 37 per cent. With higher horizontal efforts the difference between speed and current becomes still greater. At an effort of 2,000lb. the speeds are about 7·2 and 9·6, while the currents are about 70 and 105 amperes respectively. The increase in speed is about 33·5 per cent. and the increase in current about 50 per cent.

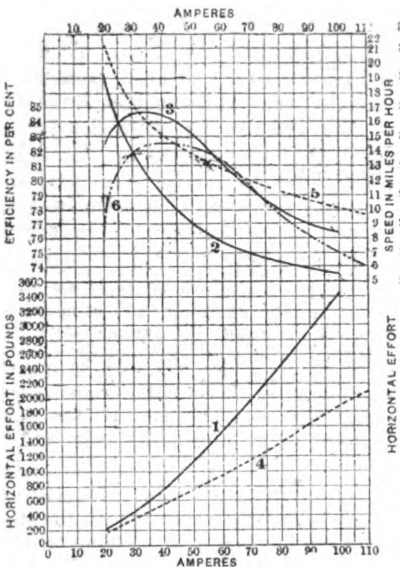

Fig. 1.

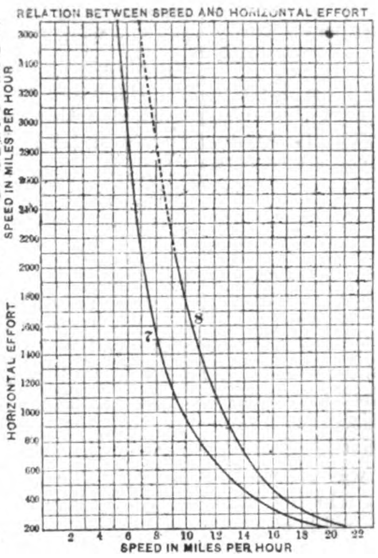

Fig. 2.

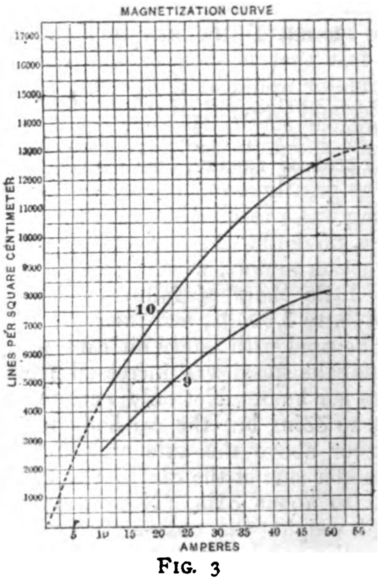

Fig. 3

The difference in the efficiency of the two motors is the natural result of the greater field cross-section. In the solid curve the maximum is reached between 30 and 35 amperes, and in the other at about 45. The explanation of this is that the proportion of the torque that is neutralised by the friction is very nearly the same in both cases, but as the large-field motors give a higher torque with the same current this proportion becomes a smaller percentage of the power developed in the case of the latter motors, hence the point of maximum efficiency is carried back to a lower current. The change in the relation of the efficiencies for currents between 60 and 70 amperes is not so easily accounted for, except upon the assumption that mistakes were made in the tests, in either or both cases, an occurrence that is possible even under the most favourable conditions. Beyond the 70-ampere point the efficiency of the solid line curve diverges rapidly from the other, which shows that the large field section increases the efficiency with large currents, a natural consequence of the lower magnetic density.

An examination of the speed curves 2 and 5 will show that with equal currents the large field cross-section runs very much slower, and the difference increases rapidly as the current increases. Thus, with 20 amperes the speeds are about 19·2 and 21·3 miles, which is a difference of close to 9 per cent., but at 60 amperes the velocities become 7·85 and 12·8 miles, the difference between which is about 37 per cent. This increased reduction in speed

From the foregoing it must be evident that to reduce the field cross-section so as to obtain higher velocity with larger efforts is not a wise course to pursue, since the increase is obtained only by the expenditure of an unreasonable amount of energy. If high-speed motors are desired, as for interurban roads, the best way to make them is with a low magnetising force and a sufficiently small number of armature-turns to obtain the required velocity with a field of as large cross-section as can be obtained conveniently. Such construction will give higher efficiency at all speeds for the same reasons that it does in generators and stationary motors. What the points here brought out show more clearly than anything else is that it is not advantageous to use motors that are designed to give a comparatively high speed when working against a high resistance for city and suburban roads. With such a construction the maximum effort is very much lower than that of motors which will slow down more, therefore the current required to start will be greater and more time will be lost in getting under headway, as the rate of acceleration will be slower.

High-speed motors, even if made with large field cross-section, are not the best for roads where there is much stopping to be done. Steam-railway men long ago found out that very little could be gained in the running time of local trains by using high-speed locomotives, because the time lost in making stops is very nearly the same in any case, and the runs are so short that the benefit of the

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greater velocity cannot be utilised to any great extent. This is equally true of electric roads where frequent stops are made, and it is demonstrated practically by the record of the old double-reduction motors, which would run on a level track at about 14 miles per hour, or at about two-thirds of the speed of modern cars, but with all this difference, the average running time was very little lower than at present.

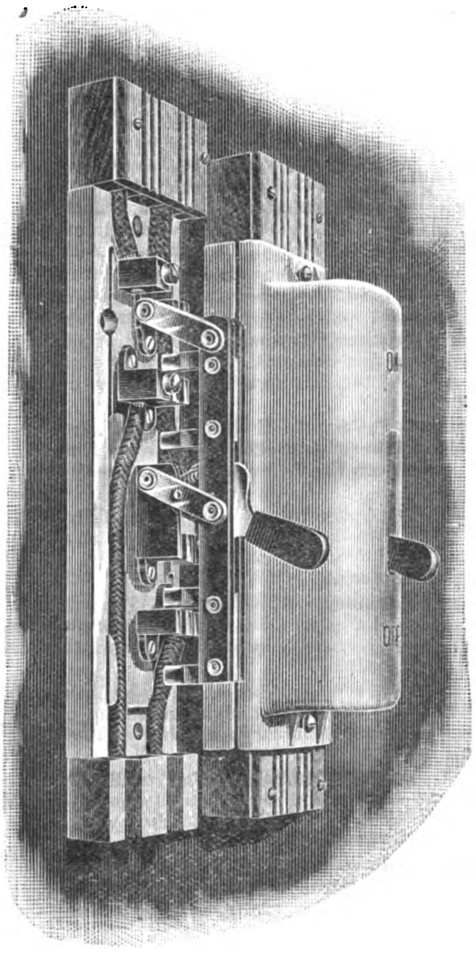
Motors that would give a speed of 15 miles with 25 amperes and an horizontal effort of 3,000lb. with less than 100 would make practically as good time as the motors now used, and would reduce the current consumption by 15 to 20 per cent.

TABLE OF CURRENT, HORIZONTAL EFFORT, SPEED, POWER, AND EFFICIENCY.

E.M.F.	Amperes	Horizontal force. Lbs	Electrical H.P.	H.P. on track.	Speed. Miles per hour	Working efficiency. Per cent.
500 volts.	20	215	13·40	11·00	19·20	82
	30	450	20·10	17·00	14·00	84·6
	40	765	26·80	22·60	11 10	84·4
	50	1,145	33 50	27 80	9·10	83·3
	60	1.570	40·20	32·70	7·85	81·6
	70	2,000	46 90	37·30	7 00	79·6
	80	2,480	53·60	41·90	6·40	78·2
	90	2,940	60·30	46·70	5·95	77·2
	100	3,460	67·00	51·20	5·55	76·4

A NEW DOUBLE-POLE SWITCH.

The accompanying illustration represents a new double-pole switch brought out by Messrs. Dorman and Smith, electrical engineers, Salford, to replace the ordinary circular type of double-pole switch on 200-volt circuits. The illustration shows



a switch to carry a 15-ampere current at 200 volts. It is claimed for it that it gives a quick quadruple break and is easily wired and erected. The base and cover are of porcelain, and it is of very high insulation. It fits neatly to casing, and has a visible "on" and "off" position. It is also claimed to be suitable for arc light circuits and perfect as a small main switch.

COMPANIES' MEETINGS AND REPORTS.

MANCHESTER EDISON-SWAN COMPANY.

An extraordinary general meeting of this Company was held on December 21 for the purpose of confirming a resolution passed a month ago in favour of the amalgamation of the Company with the Edison and Swan United Electric Light Company, Limited, on terms that have been already reported.

Mr. V. K. Armitage, chairman of the Company, who presided, said that as all present were familiar with the position of matters, it was unnecessary to add anything to what he said at the former meeting, except, perhaps, that of the £30,000 that they had to take up in debentures of the United Company, as one of the conditions of amalgamation, applications had already been received for £22,000 worth. If the resolutions adopted at the previous meeting were confirmed, the Company would go into liquidation, with Mr. J. E. Sharples and Mr. H. C. Gover as liquidators, and the Manchester Edison-Swan Company would cease to exist.

The resolutions were then formally proposed, seconded, and passed.

On the motion of **Mr. F. B. Ross**, seconded by **Mr. W. T. James Fawcus**, and supported by **Mr. I. C. Waterhouse**, the thanks of the meeting were accorded to Mr. Armitage for his services as chairman of the directorate, and for the able manner in which he had assisted in carrying through the amalgamation negotiations.

Mr. Armitage, in reply, said he had been chairman of the Board from the beginning, and as his fellow-directors had always been pleasant men to work with, the duties had been of a very agreeable character.

ELMORE'S WIRE MANUFACTURING COMPANY, LIMITED.

A general meeting of the shareholders of the Elmore's Wire Manufacturing Company, Limited, was held on December 21 at the Great Northern Hotel, Leeds. Mr. J. J. Atkinson presided.

The **Chairman** said the notice convening the meeting informed them that it was not intended to do more than to adjourn it until they could produce the audited accounts to December 31, which was necessary to enable them to properly consider the proposal made to them to amalgamate with Elmore's Patent Copper Depositing Company, Limited. He did not wish to say more on this subject than had already been stated by the chairman of the Copper Company in his speech to a large meeting of their shareholders in London on the 12th inst. The chairman of the Copper Company on the same occasion pointed out that they had, in conjunction with the Wire Company, acquired and worked out at the Leeds works a method, which is carefully patented, whereby the rate of manufacture was increased enormously. Where an order had previously taken a fortnight to execute it would be executed in under 48 hours, at a fraction of the cost, and he was far from wishing it to be understood that even that marvellous expedition was the limit attainable. If he mistook not, it meant, the chairman of the Copper Company had said, at least a great extension of their business, a very rapid turnover of their capital, large profits, and possibly a revenue of royalties. The new process was being first introduced at their works, and they were very gratified by the success which was attending its operation. The output from the mine had begun to come forward, and the sales for the same proved the reality of the benefit they were to receive from the contract in question, and they wished before meeting the shareholders again to obtain their share of the full output of the mine and to give them the results in absolute figures. The whole of those benefits had been acquired without the expenditure of a penny of their own capital, which could not fail to be satisfactory to them.

Mr. Atkinson was re-elected a director of the Company.

On the motion of the **Chairman,** seconded by **Mr. F. E. Elmore,** the meeting was adjourned until further notice, which it was stated would be issued as early as possible in the New Year.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Arlon (Brussels).—Tenders will be received on January 7 at Arlon, rue de la Station 36, for an electric generating station building at the Marbehan railway station.

Elberfeld.—Among other miscellaneous stores, tenders will be received at Elberfeld on December 30 for the supply of electric light carbons for the Prussian State Railway.

Saint-Yvon (France).—Tenders will be wanted on January 31 for an electric lighting installation (to replace 1,500 gas lights) at the lunatic asylum at Saint-Yvon, in the Seine Inferieure. Application to the asylum authorities.

Breslau.—Tenders will be received on January 12 for the supply of porcelain insulators, telegraphic wire, etc., for the Prussian State Railways. Particulars are obtainable for 50pfg. (6d.). The address is Gartenstrasse 106, Breslau.

Hull.—The Corporation invite tenders for a lease of the tramways authorised to be constructed by the Tramways Orders Confirmation (No. 1) Act, 1896. Tenders to be delivered by February 1, endorsed "Tramway Tender," at the office of Mr. R. Hill Dawe, town clerk, Town Hall, Hull, from whom all particulars and conditions of tender may be obtained.

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Brussels.—Tenders will be considered on January 8 by the Provincial Government for installing the electric light at the Office of Roads and Bridges. Particulars are obtainable at Brussels, rue des Augustins 17, and it is noted that tenders should be sent in on the 4th.

Karlsruhe.—Tenders will be received on January 2 next for an electric lighting installation for the railway station and pier at Constance for the Grand Ducal Railway Authorities. Particulars are obtainable for 10 marks (10s.) from the Generaldirektion, (Centralbureau) Grossh. Badischen Staatseisenbahnen, Karlsruhe Germany.

Harrogate.—The Town Council are prepared to receive tenders for wiring the Municipal Offices, Victoria Baths Market Hall, and Public Library; also for electrical fittings for the same. Specifications and forms of tender can be obtained at the office of the Electrical Engineer, Montpellier-gardens. Tenders must be delivered on or before January 1, 1897.

Leeds.—The Corporation require tenders for erection of a tramway depôt, including car and engine sheds, workshops, etc. The area to be covered is about 12,000 square yards. Quantities can be had at the City Engineer's Office, Municipal Buildings, on payment of £3. 3s., which will be returned on receipt of a bona fide tender. Tenders, properly endorsed, to be delivered at the Town Clerk's Office, Town Hall, by 10 a.m. on 31st inst.

Dover.—Tenders are required by the Town Council for the construction of about three miles of the Corporation tramways—single line with passing places—including a concrete road bed, the laying of rails, tie-bars, etc., and paving with granite setts, for the Town Council. Forms of tender, specifications, and bills of quantities may be obtained on payment of £3. 3s., returnable on receipt of a bona fide tender, and conditions and plans inspected at the Borough Engineer's Office, Town Hall, on and after 28th inst. Tenders to be sent in to Mr. E. Wollaston Knocker, town clerk, Town Clerk's Office, Castle-hill House, Dover, by 2 p.m. on January 12.

Dover.—The Town Council also invite tenders for the supply and delivery of steel girder rails, fishplates, fishbolts, tie-bars, points, crossings, and other accessories for about three miles of the Corporation tramways. Forms of tender, specifications, and bills of quantities may be obtained on payment of £3. 3s. (returnable on receipt of a bona fide tender), and conditions and plans inspected at the Borough Engineer's Office, Town Hall, on and after 28th inst. Tenders to be sent in to Mr. E. Wollaston Knocker, town clerk, Town Clerk's Office, Castle-hill House, Dover, by 2 p.m. on January 12.

Colwyn Bay.—The Urban District Council invite plans, particulars, and estimates, etc., for a scheme of electric lighting for their district, the powers for which they obtained last session. To the author of the scheme considered the best a premium of £30 will be paid, and in the event of the work being carried out such premium must be considered as part payment of the engineer's commission. To the author of the scheme considered second best a premium of £20 will be paid. Further information will be received on personal application to Mr. Wm. Jones, A.M.I C.E., the Council's surveyor. The schemes must be sent in not later than January 12, 1897. Further particulars are contained in an advertisement in another part of the paper.

Montevideo.—We have received information from the Foreign Office that the Uruguayan Government are calling for tenders for working the electric light system in the town of Montevideo, in accordance with Art. 25 of the law of liquidation of the Banco Nacional. The principal conditions are that the renting company shall take over the payment of all the private debts of the concern, which, on September 30, 1895, were as follows: Banco Hipotecario del Uruguay, mortgage in cedulas on the central station in Calle Yerbal, 63,865dol.; mortgage on the central station in Arroyo Seco, 71,411dol.; Ernesto Tornquist, for machinery, 29,332dol To carry out the public lighting at a price 5 per cent. below that actually paid for the first five years, and 10 per cent. discount for the second five years. The rental to be for 10 years. The renter to take over the debts of the concern. The renter to purchase 400 shares at present in private hands. Tenders to be presented on January 15, 1897, at 2 p m. A guarantee of 10,000dol. to be given. Tenders are to be sent in sealed envelopes to the Ministry of Finance, and will be opened in the presence of the interested parties.

RESULTS OF TENDERS.

Breslau.—The tenders on December 14 of seven firms for the supply of telegraph posts (about 32ft.) to the State Railway at Breslau varied from 7·50 marks (7s. 6d.) to 5 marks (5s.).

Dundee.—The Directors of the Royal Infirmary having agreed to light the new nurses' home at the infirmary by electricity, have accepted the tender of £100 sent in by Messrs. Lowdon Bros, Tay-street.

Darmstadt.—In the contracts for railway stores during 1897 for the Main and Neckar Railway on December 10 the contract for sulphate of copper was not tendered for, and the tenders for telegraphic paper varied from 10pfg. to 8½pfg.

Portsmouth.—The Town Council have accepted the joint tender of Messrs. Yates and Thom and S. Z. de Ferranti, Limited, for the supply of new plant at the electric light works. The amount of tender, after deducting 5 per cent. off the sum quoted for the engine, which was agreed to, was £8,448. 17s. 6d.

Shoreditch.—The Vestry have received the following tenders for the supply of wiring materials. Accepted tenders:—Henley's, 27, Martin's-lane, E.C., wires and cables; British Insulated Wire Company, Prescot, wires and cables; General Electric Company, 69, Queen Victoria-street, E.C., instruments, tools and sundries; J. Williamson and Son, 92, Queen Victoria-street, E.C., switches, etc. Also tendered: Drake and Gorham, 66, Victoria-street, S.W.; Edison and Swan, 36, Queen-street, Cheapside; Fowler, Lancaster, and Co., Graham-street, Birmingham; Francis and Spilsbury, 20, Bucklersbury; India Rubber and Gutta Percha Company, 106, Cannon-street, E.C.; Johnson and Phillips, 14, Union-court, E.C.; Lyel and Co, 56, Victoria-street, S.W.; Paterson and Cooper, 68, Victoria-street; Siemens Bros., 12, Queen Anne's-gate; Lancashire Electric Company, Kingsland-green; International Electric Company, 55, Red Cross-street, E.C.; Telegraph Manufacturing Company, Helsby, Warrington; Verity's, 31, King-street, Covent Garden.

London.—The County Council have received the following tenders for lighting the Whitefriars fire-engine station with electricity, £50 being included in each case for contingencies:

Private Wire and Telephone Installation Company (accepted)	£368	16	0
Brush Electric Engineering Company, Limited	375	0	0
Drake and Gorham	415	0	6
Russell and Russell	444	0	0
R. F. Barrett Lennard	463	2	6
Crompton and Co., Limited	480	0	0
F. A. Glover and Co.	489	0	0

BUSINESS NOTES.

Western and Brazilian Telegraph Company.—For the past week the receipts were £2,636.

Fort William.—The new post office, for which a site has now been found, is to be lighted throughout by electricity.

Howth.—A public meeting has been held in support of the Clontarf and Hill of Howth electric tramway which it is proposed to construct.

Witham.—Mr. J. Aloysius Kuner, who has recently taken possession of the Crown Inn, has had an electric light installation erected on his premises.

Uruguay.—In entering into contracts for works in Uruguay it is well to remember that at present there seems to be something very like a revolution going on there.

Mangotsfield.—The Parish Council have appointed a committee to meet the Bristol Tramways Company respecting the proposed extension into the district of Staple Hill.

Morley.—The Town Council have resolved to apply to the Board of Trade for a provisional order to supply electricity within the borough for lighting, power, and heating.

Kensington.—The question as to the advisability of opposing the City and West-end Railway scheme has been referred by the Vestry to the Law and Parliamentary Committee.

Electrical Traffic Syndicate, Limited.—This Company has been registered, with a capital of £1,000 in £1 shares, to develop and further the use of electricity in connection with traction.

Anglo-Portuguese Telephone Company.—Coupon No. 18 of the first mortgage and No. 13 of the second mortgage debentures will be paid, less income tax, by Parr's Bank on and after 1st prox.

National Telephone Company.—The transfer books of the 3½ per cent. debenture stock will be closed till the 31st inst. for the preparation of the warrants for the half-year's interest due January 1.

Warrington.—The Special Electric Lighting Sub-Committee of the Town Council have instructed the town clerk to make application to the Board of Trade for power to supply the town with electric light.

Killarney.—Dr. Griffin reported at the meeting at the District Lunatic Asylum that the electric current was now supplied and the asylum lighted by it. The current had been steady, and the light quite satisfactory.

Electrical Machinery.—At the second ordinary general meeting of Messrs. R. and J. Pullman, the Chairman stated that they were about to introduce electricity in connection with the manufacture of some of their products.

Berlin.—Electric tow boats are about to be placed on the River Spree, where for a distance of eight miles the ordinary barges cannot use sails owing to a large number of low bridges. The trolley system will be used.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended December 20 amounted to £1,116, as compared with £1,080 in the corresponding week of the previous year, being an increase of £36.

Tunbridge Wells.—Mr. H. L. P. Boot, the borough electrical engineer, delivered a lecture last week entitled "The Electric Light in Tunbridge Wells." The lecture was given under the auspices of the Tradesmen's Association.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ended December 18 were £1,859. 4s. 8d., compared with £1 780 16s. 7d. for the corresponding period of last year, being an increase of £78. 8s. 1d.

Croydon.—The Corporation have decided, on the advice of Prof. Kennedy, to provide a cooling tank for the condensing plant at the electric lighting station, in lieu of conveying water direct to the condensing plant, as originally intended.

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Bedford.—A deputation from Reigate Town Council visited the electric light works last week and were shown over the public buildings and town by Alderman Richards.

New Book—An illustrated book has just come from the press giving in popular language an account of the progress of electric traction. Its title is "Electric Tramways and Railways Popularly Explained," and the author is Mr. H. Scholey.

Dangerous Trades.—Acting under Section 8 (1) of the Factory and Workshop Act, 1891, the Home Secretary has certified that the process of vulcanising indiarubber by means of bisulphide of carbon, and the processes incidental thereto, are dangerous or injurious to health.

Electric Lighting of Trains.—A successful experiment has been made in lighting the London, Chatham, and Dover Railway Company's boat express trains with electric light, the current for which is generated by the train's motion. The light is to be used in the new corridor trains.

New Year Number.—We have received a copy of an established monthly magazine called *Mothers and Daughters*, with which is given away a bound supplement containing a complete story "True till Death." The book is published at the low price of a penny from *Great Thoughts* office.

City and South London Railway.—The returns for the week ended December 20 were £1,082, compared with £1 013 for the corresponding period of last year, being an increase of £69. The total receipts for the half-year 1896 were £24,103, compared with £22,553 last year, being an increase of £1,550.

Farnworth.—At the District Council meeting a resolution in favour of applying to the Board of Trade for a provisional order for the supply of electric energy for all public and private purposes as specified in Section 3 of the Electric Lighting Act, 1882, within the Council's area, was formally adopted.

Warminster.—Having considered a letter from the Board of Trade with reference to the existing electric light cable, the General Purposes Committee recommended at the Urban District Council meeting that it should be removed by disconnecting it near Mr. Mark Hill's yard. This was agreed to.

Walsall.—A slight accident occurred last week on the electric system of the South Staffordshire Tramways between Walsall and Darlaston. Two cars—a passenger car and a special freight car—collided with each other. The driver of one of the cars sustained a slight injury to his ankle, but no one else was hurt.

Bedminster.—At the Parish Council meeting, Mr. Enwright proposed, "That this Council regrets the decision of the Bristol Town Council with reference to the tramways extension, and considers it a distinct violation of their pledge." Six voted for and six against the motion, the chairman refusing to vote.

Brighton.—The *Sussex Daily News* has an interesting little article on electric lighting at Brighton, showing that on December 19 there were 1,357 private customers—a net increase of 300. Electricity for motive power is also on the increase, and the lighting of the street lamps is being extended very rapidly.

Makin, Smith, and Co., Limited.—This Company has been registered, with a capital of £1,000 in £1 shares, to carry on the business of an electric light company, and of electricians. mechanical engineers, and suppliers of electricity; as electrical apparatus manufacturers, etc. Registered office: 19, Ramsden-street, Huddersfield, Yorkshire.

Electric Ploughs.—In reference to the experiments in electric ploughing that have been made in Germany, it may be stated that the German Agricultural Society are offering a prize for improvement in steam ploughs "or ploughs operated by power other than from animals." The conditions are given fully in the *Elektrotechnische Zeitschrift* of November 12.

York.—Tenders for the electric lighting of the city were opened by the Streets and Buildings Committee of the Corporation at their meeting, and were ordered to be submitted to Prof. Kennedy. It is stated that the tenders were less numerous than they have been on previous occasions, and that none of the firms have tendered for the working on a term of years.

Morecambe.—The Lighting and Water Supply Committee reported at the District Council meeting that they had received a letter from Messrs. Hargreaves and Co., London, agents to Mr. Tilly, respecting application for a provisional order for the electric light undertaking. It was decided that the agents be instructed to proceed with the printing and depositing the provisional order. This report was adopted.

Commercial Changes.—By an arrangement between the Epstein Electric Accumulator Company, Limited, and Mr. L Epstein, the latter, in order that he may devote more time to other business, and especially to electric traction. has resigned his position as managing director of the Epstein Electric Accumulator Company, Limited, retaining his seat on the Board and acting as consulting engineer to the company.

Newcastle.—The Queen's Commemoration New Infirmary Fund Committee have accepted the offer of Mr. H. Engel to issue and place on sale 100,000 tickets of admission at the ordinary price of 1s. each, and available at any time, and on any one day during the run of the electrical exhibition, and if these were sold by the time the exhibition was opened he would give a donation of £1,000 from the funds of the exhibition.

New Traffic Syndicate, Limited.—This is the title of a company which has been registered, with a capital of £12,000 in £1 shares, to promote the interests of the movement or industry of placing motor vans, motor wagons, and all kinds of mechanically-propelled vehicles on the common roads, and to carry on the business of electricians, cycle, motor, and carriage manufacturers, etc. Registered office: 6, Old Jewry, E.C.

Radcliffe.—At the meeting of the District Council the Chairman of the Electric Lighting Committee reported that as a result of a visit to the Nelson electricity works he believed it was quite possible for an electric lighting installation to be self supporting in Radcliffe. It was resolved that application should be made to the Board of Trade for an extension of time for the carrying out of lighting in the compulsory area.

Limehouse—The District Board have agreed to consent to the application of the County of London and Brush Provincial Electric Lighting Company, Limited, for a provisional order under the Electric Lighting Acts, 1882 and 1888, in the form submitted by the company, in respect of the district of the Board, subject to the omission therefrom of Sub-clauses 2 and 3 of Clause 55 relating to the purchase of the undertaking by the Board.

Belfast.—At the meeting of the Electric Committee the engineer reported matters of detail in connection with the working of the department and the new plant recently erected, and received instructions in these matters. The question of the site for the proposed station was again under consideration as the site selected was held to be necessary for the requirements of another committee, and the town clerk was instructed to report on the matter at next meeting.

Hampstead.—At the meeting of the Vestry a long discussion took place on the proposal of the Finance, Lighting and Works Committees to transfer the insurance of one of the alternators in the central electric lighting station and some of the public buildings from the Norwich Union Fire Office to the Fine Art and General Insurance Company, the proposal being agreed to by a very large majority. It was stated that a very considerable saving will be effected by the transfer.

Telephone Workers' Conference—An adjourned conference of telephone workers from various parts of England took place on Sunday afternoon at Leeds. Certain proposals were formulated, and these will be forwarded to the headquarters of the Gasworkers' and General Labourers' Union in London, the officials of which will bring them before the directors of the National Telephone Company. After receiving a reply from the company another conference will be called, if necessary, to consider the matter.

Birkenshaw.—At the meeting of the District Council it was decided to invite the Gomersal District Council to meet the Birkenshaw Council and discuss the question of formulating a scheme of electric lighting for the two districts. The matter had been discussed previously by the Finance Committee, who recommended that this course should be taken. The Chairman (Mr. B. Crowther) stated that the committee were in favour of promoting a scheme on their own account if Gomersal would not join them.

Dover.—At the meeting of the Managing Committee the Tramway Sub-Committee recommended that the tenders for the lines be invited in three contracts—one for the rails and other metal works, the second for the permanent way, and the third for the electrical equipment. In connection with the third they recommended that Mr. Sellon's services should be retained. and his remuneration should be 5 per cent. on that portion of the tramway's expenses. The minutes were approved and the tenders ordered to be invited.

Fyvie—A meeting of villagers has been held for the purpose of considering as to the lighting of the village, and whether that should be done by means of gas lamps or electric lights. There was a good attendance. A committee was appointed, consisting of Mr. Mackie, Lewes; Mr. Stephen, Ashgrove; and Mr. Ogg, to make all necessary arrangements in getting an estimate of the expense, not only of gas lamps, but also of the electric light, as water power could be obtained. The committee will report to another public meeting.

The Giant's Causeway Electric Tramway.—Some correspondence has passed between Mr. Jas. Boyle, J.P., Ballymachrea, Portrush, and the Board of Trade with regard to the system of traction employed on the Portrush and Giant's Causeway tramway. In reply to Mr. Boyle, Mr. F. J. Hopwood, of the Board of Trade Railway Department, says he is directed by the Board of Trade to inform Mr. Boyle that they do not appear to have any authority to compel the company to stop the electric working of the line, which was authorised by a special Act of Parliament.

Stapleton.—At the meeting of the Urban District Council a deputation from the directorate of the Bristol Tramways Company attended for the purpose of interviewing the Council upon the question of the proposed extension of the electric tramways through the parish of Stapleton to Staple Hill. The deputation consisted of Mr. George White (chairman of the board of directors), Messrs. S White (secretary), H. G. Doggett (solicitor), and G. T. Edwards (engineer). After discussion of the various points in the company's proposed Bill, a resolution was passed consenting to the Bill.

Kingston—Councillor Collings has been reappointed chairman of the Lighting Committee. The Chairman reported at the Town Council meeting that an arrangement had been arrived at with the consulting engineer, Mr. A. H. Preece, in regard to his relations with the committee. The committee recommended that the arrangement be agreed to, and also that the Corporation seal be affixed to an agreement with the Surbiton Urban District Council as to the discontinuance of supplying electricity at the assembly rooms in the event of the Council themselves being in a position to do so. This was agreed to.

Newmarket.—At an adjourned meeting of the Urban District Council the Surveyor submitted his estimate of the sums proposed

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to be spent in connection with the electric lighting provisional order applied for by the Council as follows: engine and boiler house plant, £5,000; buildings, chimney, and foundations, £2,200; mains, £2,500; provisional order, £300—total, £10,000. After discussion, it was decided to add £500 for the purchase of land for the works, and the clerk was instructed to deposit the necessary documents with the Board of Trade, including a statement that the proposed expenditure would be £10,500.

Cromer.—Mr. Broadhurst asked at the Town Council meeting if it was to be understood that the Council had abandoned its intention of protecting itself in the matter of the electric light. The Chairman replied that when the cost of a provisional order was named the matter was dropped. Mr. Broadhurst said he did not propose to argue the subject. He only wished the Council to realise the importance of the step that it had taken, and for the members to be prepared to stand by the responsibility of the action. He was sure that they would regret the decision one day. However it was open for the subject to be brought up again.

Lisburn.—A special meeting of the Street Committee has been held to consider the advisability of engaging a competent electrical engineer to report as to whether electric lighting plant could be erected for the purpose of lighting the town by electricity. Mr. G. B. Wilkins (chairman) presided. The matter having been carefully considered, and several engineers having offered their services, it was unanimously resolved that Mr. E. S. Dashwood, electrical engineer to Messrs. William Coates and Son, Belfast, be appointed consulting electrical engineer to the Town Commissioners, and to report fully on the best system for lighting the town.

Diary.—We have received a copy of the *Indian and Eastern Engineer* diary for 1897. This book contains a lot of particular information relating to Indian postage, shipping, railways. The abstract of customs tariffs for India, Siam, Corea, Japan, Ceylon, England, etc., will be found very useful. The information relating to railways and tramways, not only in the Indian peninsula, but the Far East generally, is very full and very valuable. The useful tables of Oriental weight are repeated, but we still miss what is much wanted—viz., tables of the coins of China, Persia, and the Malay peninsula. In all other respects this diary ranks among the best that are published.

Another Electric Railway.—A railway is projected which will connect High Beech with Moorgate-street and work in conjunction with the Great Northern and City Railway. For about four miles the line will be constructed in two parallel tunnels, and the remainder will be in the open. The tunnels, as in the case of the Great Northern and City, will be 16ft. in diameter, and at an average depth of about 40ft. The Act authorises the use of both steam and electric locomotives. The Great Northern and City is at present restricted to electricity, although the Bill it will present to Parliament in 1897 will provide for steam as well. It is expected than an active commencement will be made on the work of construction early in the New Year.

Proposed Amalgamation.—The stockholders of the Commercial Cable and the Postal Telegraph Cable Companies met on December 22 to vote on a proposition to exchange the stock of the Postal Company (15,000,000dol.) dollar for dollar, for new 4 per cent. gold bonds of the Commercial Cable Company, part of an issue of 20,000,000dol., of which 5,000,000dol. will remain in the treasury. The Postal Company paid its first dividend at the rate of 1 per cent. quarterly in April, 1896. The Commercial Company has paid 7 cent. annually since 1891, and last week declared an extra dividend of 1 per cent. The two organisations have been working together on an agreement which expires this year, and it was decided to make the union a permanent one.

Middlesbrough.—A proposal was made at the meeting of the Streets Committee for fixing incandescent lights to all the burners except the chandeliers. Councillor Carter thought they should let the matter stand over, as next year they might be going in for the electric light. Councillor Keay expressed a similar opinion, and moved as an amendment that the matter stand over for 12 months. Mr. Carter seconded, but the amendment was lost and the motion was adopted. The question of granting permission to the Imperial Tramway Company to extend the tramways in the town and adopt the overhead electric trolley of traction was again considered. It was ultimately agreed that the chairman and town clerk formulate questions for reply by the tramway company.

Turin Exhibition.—In reference to the international electrical exhibition to be held in Turin in 1898, the Executive Committee and the Special Commission, of which Prof. Galileo Ferraris is president, invite exhibits from all parts of the world. The exhibition will embrace the following classes: (1) apparatus for teaching electrotechnics; (2) materials for conduction of electricity; (3) instruments for electric and magnetic measurements; (4) telegraphs and telephones; (5) signalling apparatus and safety appliances on railways, lighting and heating of carriages; (6) dynamos and motors; (7) mechanical appliances and electric traction; (8) electric lighting; (9) electro-chemistry and electro metallurgy; (10) miscellaneous; (11) apparatus of historic interest.

Watford.—At a meeting of the Urban District Council it was reported that at a meeting of the Electric Lighting Committee a letter from Mr. Hawtayne was read, stating that he had had several interviews with Messrs. Shone and Ault on the subject of the proposed combined electric lighting and sewerage works for Watford, and as a result a rough general plan of the buildings had been prepared by them and was being forwarded, adding that there would be a few minor alterations to be made, and he should be glad to meet the committee at an early date to discuss the matter with them. The committee were invited to inspect the plan when received, and, if necessary, the clerk was authorised to arrange a meeting with Mr. Hawtayne. Ultimately it was decided that a committee of the whole Council should consider the scheme.

Epsom.—At the Urban District Council meeting the Lighting Committee presented a draft memorial to the Board of Trade applying for a provisional order giving the Council power to introduce the electric light in Epsom for public and private purposes. Mr. Langlands enquired what the cost would be. In the first instance they were informed that it was to be £25. That amount had been incurred, and in addition another £50. Mr. Beams said he understood the initial cost would be £200. Mr. Jay asked if it would be a valuable property when they had obtained the order. The Chairman said as far as he understood the matter it would. If they decided not to make use of the powers conferred upon them by the order, they could turn them over to a company. He moved that the memorial be sealed and signed. This was seconded by Mr. Beams, and carried.

Wolverhampton.—The following resolution was adopted at the Town Council meeting: "That subject to an agreement being entered into between the Dudley and Wolverhampton Tramways Company, Limited, and the Corporation, containing the same terms and conditions as the existing agreement, with the addition of a condition requiring that the company shall not on Sundays load or unload their cars, or permit or suffer the same to be loaded or unloaded, or permit or suffer their engines or cars to stand upon any portion of their line to the northward of George-street, in this borough, the Council do grant their consent to the use of steam on the Dudley and Wolverhampton tramways (so far as the same lie within this borough), from November 14, 1896, until November 14, 1897, unless in the meantime such consent be withdrawn in pursuance of the terms of the proposed agreement."

The Electrical Company.—We have received from the Electrical Company, Charing Cross-road, a tastefully got-up little pamphlet, entitled "A Glimpse into the Factory of our E.C. Incandescent lamps" From the numerous illustrations (they are German—not English) the amount of the work of lamp-making that gets done by women would appear to be pretty considerable. Of course, they do not blow glass or fire it, and it would seem that they are not wholly to be trusted for packing, but otherwise they seem to have it very much their own way all over the place. With this the Electrical Company send us the radiography (Röntgen ray) apparatus price-list. They adopt platino-cyanide of barium for the screen and make a T-shaped tube with two anodes and a cathode where the three arms meet, but in the instructions for use there is a direction which is equivalent to saying "use one anode if it works better."

Ardrossan.—The new installation of electric light at the harbour was turned on on Friday evening last by Mrs. Hugh Hogarth in presence of a large gathering of local ladies and gentlemen. Mr. Craig, harbour manager, who presided, explained that electric light was first introduced at the harbour in September, 1892, but the installation at that time was confined to the Eglinton Dock and Montgomerie Pier Station. The new installation embraced the old dock. The installation of 20 lamps had been increased to 43 altogether of 3,000 c.p. each. In the old system, when one light went out, all the others went out too, but under the new system when one light went out it did not affect the others. In the old lamps the carbons only burned for about 12 hours, or perhaps less; the new carbons burned for 20 hours. The improvements in the new installation would be extended to the old one as soon as possible. The dynamos were driven by two separate engines, steam being supplied from the boilers connected with the hydraulic engines. The extension had been carried out by a competent staff, under the direction of Mr. Stevenson, electrical engineer for the Caledonian Railway Company.

Leeds.—For the purpose of considering the best means of providing a new central tramway depôt a special meeting of a sub-committee of the Tramways Committee has been held. The city engineer submitted for approval plans for car and engine sheds on Kirkstall-road, shed for repairs, and other new buildings in connection with the working of the tramways of the city. The area over which the proposed premises are to be built is about 3½ acres. There is to be accommodation for 150 cars, including 50 electric cars and 24 locomotives. According to the plans, there are also to be repairing sheds for cars and for locomotives, and workshops for joiners, mechanics, blacksmiths, painters, and other workmen. The meeting decided that the city engineer should complete the plans for the new depôt, and invite tenders to be sent in at such date as would enable them to be laid before the committee at its next meeting, and if approved of submitted to the City Council at its January meeting. It was agreed to hold the meeting of the committee to consider the tenders on the last day of the year. The question of central offices for the tramway business was considered, but it was decided not to build any offices at this depôt.

Portsmouth.—The Electric Light Committee recommended the Town Council at the last meeting to accept the joint tender of Messrs. Yates and Thom and S. Z. de Ferranti, Limited, subject to a deduction of 5 per cent. off the sum quoted for the engine, which had been agreed to, also that a joint contract be entered into by the two firms for the supply of the whole of the plant. The amount of the tender, after allowing for the deduction, was £8,448 17s. 6d. Mr. Evans asked why the work was not tendered for. Mr. Dittman asked how much the engine would cost. In reply, Alderman Ellis said the cost of the engine was £5,000 odd. No one could tender for the work but Ferranti's. Mr. Dittman said that other firms than Yates and Thom could tender for the engine, and tenders ought to have been asked for. Mr. Dummer thought that

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tenders should have been invited. There was much more discussion, during which Sir John Baker said it would be very unwise not to support the committee's recommendation. He suggested, however, as a safeguard, that the excellent Electric Lighting Committee and the trebly excellent chairman should allow it to be known that in future two or three good firms should be asked to send in prices. The recommendation of the committee was carried

Glasgow.—Mr. D. M. Stevenson asked at the meeting of the Corporation whether there was anything to prevent the gas and electric lighting services being made separate departments under the existing Acts of Parliament. Mr. Monro replied that he was not aware that there was anything to prevent the two departments being separated. The Corporation Tramways Committee, at a meeting last week, considered an offer to equip the cars with a new motor. The motor proposed is on the oil principle, and is the joint patent, it is stated, of Mr. George Johnstone and Sir William Arrol. The offer is to equip every tramway route in Glasgow with cars driven by mechanical traction, and to run these for a period of seven years at a cost to the tramway department not exceeding what it at present pays for horse haulage. At the end of the seven years the promoters undertake to hand over to the Corporation, as a free gift, the whole of the cars, with their motors, in good working condition, and free of any charge for royalties. It is calculated that horse haulage costs £100,000 per annum. The patentees are prepared at their own expense to furnish within four months motorcars for any route in the city, on the condition that, should the Corporation decide, after two months' trial, that the cars are unsuitable, they shall be withdrawn, and the community held in no way responsible for the expenditure incurred. After discussion, the committee decided to give all reasonable facilities to the inventors.

Jamaica.—The application lately made by the Jamaica Street Car Company, Limited, under the Tramways Law, 1895. for a license to establish tramways in Kingston and its environs having been refused by the Governor in Privy Council, parties willing to undertake the establishment and working of a system of rapid transit within the above district are again invited to forward applications for a license therefor, under the provisions of the above-mentioned law and the rules made thereunder. Applications must be addressed to the Clerk of the Privy Council, in Kingston, Jamaica, and should be enclosed in sealed envelopes, endorsed "Application for Tramway License." It has been decided by the Governor that he will not fix, under Section 6 of the Tramways Law, 1895, an earlier day than April 15 next for bringing any such application before the Privy Council for consideration; but on receipt of the first application the Governor will fix April 15, or the earliest possible subsequent day, for bringing it, and all other applications, if any, which may then be ripe for consideration, before the Privy Council, as provided by the above-mentioned section. Copies of the Tramways Law, 1895, and of the rules made thereunder by the Governor in Privy Council, and maps of Kingston and the surrounding parts of the parish of St. Andrew, may be seen in London at the office of the Crown Agents for the Colonies; in New York at the office of Messrs. Gilliespie Bros and Co., 4, Stone-street; and in Kingston, Jamaica, at the office of the Colonial Secretary.

Moss Side.—At an ordinary meeting of the Urban District Council it was reported that at a special meeting of the Council held on the 17th inst. an agreement with the Manchester Corporation with reference to the electric lighting order was approved. The main provisions of the agreement were that the Corporation should take a transfer of the order and become the undertakers to supply the Moss Side district with electric lighting for a term of 15 years, refunding to the Council the cost of obtaining the order and of the transfer deed, on condition that the charges in the Moss Side district were in all respects the same as those made within the city; that the Council could repurchase the undertaking within six months after the term of 15 years, or any subsequent fifth year; and that within two years preceding any purchase period no expenditure exceeding £100 on capital account should be incurred without the approval of the Moss Side Council, except in case of emergency, with a special provision in that event; and that the Corporation should not mortgage the Moss Side general district rate nor the Moss Side portion of the undertaking. The Chairman, in moving the adoption of the minutes of the special meeting, said what had been done was of great importance to the district. He thought that the ratepayers would cordially approve of the agreement with the Manchester Corporation for the electric lighting of the district, especially in regard to the clause giving the Council the power of taking over the undertaking, if they were in a position to do so, at the end of 15 years. The proposal of the chairman was seconded, and the minutes were unanimously approved.

The Postal Telegraph Staff.—A meeting of members of the London branch of the Postal Telegraph Clerks' Association was held last week. Mr. A. S. Nicholson occupied the chair, and, in opening the business, said they were met to crystallise the sentiment of dissatisfaction and discontent which existed amongst the members of the staff with regard to the arrangements for holidays next year, by which a large number were obliged to take their annual leave during January, February, November, or December. They would also be asked to press upon the Government the necessity for the early issue of the report of Lord Tweedmouth's Committee Their staff was obliged to keep in good health for the serious character of the work which they had to perform; but it was impossible to get the advantage necessary from a holiday in the winter months. The only way of effecting an alteration would be to increase the staff, which meant more money expended; but with an increase of staff they might be able to get rid also of the "long and short duties," which was one of their grievances. There was a profit handed to the Treasury of more than £3,000,000 a year, and he considered that to pay over £3,000,000 ought to satisfy the Government, and the surplus above that should go in aid of the working of the Department. Such an allowance would enable the Department to relieve the pressure, and so remove the grievances under which the Department laboured. There were 3,000 members of the staff who were waiting anxiously for the report of Lord Tweedmouth's Committee, and he thought they had shown great forbearance in the matter. A resolution asking the Postmaster-General to introduce for 1897 a more satisfactory arrangement of the periods of annual leave was passed unanimously, and the form of a memorial in which the resolution was embodied to be presented to the Duke of Norfolk as Postmaster-General was agreed to. The second resolution pressed for the early publication of the report of Lord Tweedmouth's Committee, and the meeting closed with a vote of thanks to the chairman.

Cardiff.—At the meeting of the Tramways Committee held yesterday week the question of the purchase of the tramways, which at the last meeting of the Council was referred back to the committee for further consideration, was again discussed A report was submitted by the town clerk as to the dates and terms of purchase and the exact position of the Corporation in relation to that of the tramway company. Alderman Carey put the following question: Supposing we agreed to buy the tramlines within a few weeks, can we buy at 30 per cent.? The Town Clerk answered in the affirmative. Mr. Waring: And the rolling-stock as well? The Clerk: That is so. Alderman Carey: Will the 30 per cent. apply to the plant as well as to the lines? The Town Clerk: Yes. Ultimately, the following resolution, proposed by Mr. Lloyd Thomas, was carried with three dissentients: "After considering the report of the town clerk this committee desires to recommend the purchase of the tramway lines and depôts for £61,000, the lines to be leased to the Corporation for a term of 15 years at a rental of 5½ per cent.; that the existing lines be made equal to new; that the cost of repairs be met by the company; that the fares be not raised; that the lines be doubled where necessary and convenient; that electrical, mechanical, or other traction be used when called upon by the Corporation, and that all extensions of the newly constructed lines be renewed on the same basis" A meeting of the Joint Parliamentary and Tramways Committee has also been held. It will be remembered that at the last meeting of the Council they referred back the recommendation made by the Joint Tramways and Parliamentary Committees to the effect that leave be not given to the Cardiff and Penarth Electric Tramway Syndicate to apply for a provisional order. At the Council meeting the town clerk read a letter from Mr. Ivor Vachell, solicitor to the Penarth Electric Railway Syndicate, offering, if the Joint Committee thought well, to meet them to talk the matter over. Eventually, on the motion of Councillor Crossman, seconded by Councillor Tucker, it was resolved to adjourn the meeting for the exclusive purpose of receiving a deputation from the syndicate should they wish to appear.

Hull.—A letter has been received by the Electric Lighting Committee from the secretary of the North-Eastern Railway Company stating that the directors had under consideration the question of lighting their station hotel at Hull by electricity, and he was desired by them to enquire at what price per Board of Trade unit the Corporation would be prepared to supply electric current for the purpose. The number of lights to be provided was estimated to be equal to 700 16-candle lamps or their equivalent in larger or smaller lamps. After some discussion it was resolved that the engineer report on the subject. The committee have confirmed the minutes of the sub-committee, which stated that having considered the letter from the Electric Lighting Extension Syndicate, Limited, it was moved and carried that the letter and draft terms proposed by the syndicate for erecting penny-in-the-slot meters lie on the table for six months. Now, that on the third time of asking the Council has by a majority of 29 passed the scheme it twice previously rejected, it is expected that the work for the extensions will be proceeded with rapidly. The question of the sub-stations has been left in the hands of Mr. Skinner, Mr. Millington, and the electrical engineer to select suitable sites, and a resolution was proposed at the meeting of the Electric Lighting Committee to the effect that the engineer should prepare plans and specifications for the proposed extension scheme. A long discussion took place on a proposition that Mr. Hammond be engaged as consulting engineer to assist Mr. Barnard, at a remuneration of 500 guineas, and ultimately it was decided to write to Mr. Hammond on the subject. The matter has been going on so long that it may be well to briefly remind our readers that the accepted scheme is one for giving the new area a continuous-current supply on the three-wire system at 440 volts between the outers, and derived from a transforming station fed by a high-tension feeder (2 000 volts) from the central station, leaving the old 220 three-wire system intact. An amendment to make the new scheme include East Hull was ruled out of order. The idea of the majority of the Council as opposed to the committee, though not definitely formulated, appeared to be either to have an entirely separate generating station for the extensions or, alternatively, to make such alterations in the existing work as would enable it to carry 440 instead of 220 volts. A special meeting of the Electric Lighting Committee has since been held, when it was decided to apply for power to borrow £10,000 to extend the electric light to East Hull.

Reading.—At a special meeting of the Corporation the Tramways Committee reported that they had received a letter from Mr. J. Clifton Robinson, managing director of the Imperial Tramways

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Company, Limited, dated December 7, in the following terms: "Referring to our application 14th ult. and to the Finance Committee's recommendation, adopted by the Council on the 3rd inst., the directors desire to say that having regard to the general feeling of the Council as indicated during the discussion of the report, they are prepared to submit the following to your committee as an alternative proposition: The company will agree to sell at once to the Corporation the whole of their undertaking under the provisions of the compulsory purchase clause of the General Tramways Act, 1870, and in the event of such sale being effected the company would be prepared to take a lease of the lines on terms and conditions to be arranged, the Corporation assenting to the carrying out of the company's order, subject to any modification of the extensions, set forth in the plans and sections, as may be mutually agreed upon. There are other points which will arise in discussion, and I shall be pleased to meet your committee for this purpose." It was resolved that the town clerk should inform the Reading Tramways Company, Limited, through their secretary, that the letter submitted did not indicate a sufficiently clear basis upon which the Council could proceed to negotiate with the company. The committee considered generally the course which should be taken on the subject of tramways in the borough, and resolved that in the opinion of the committee the Council should determine without delay the general question whether the existing tramways or any future tramways within the borough should be in the hands of the Corporation, the method of working such tramways, whether by electric traction or otherwise, and if they should determine that the tramways should be in the hands of the Corporation, and that electric traction should be used, the expediency of acquiring the undertaking of the Reading Electric Supply Company, Limited; and that in connection with this subject the Council should consider the question of the probability of their constructing at some future time light railways under the provisions of the Light Railways Act, 1896, and of the same being worked by electric traction. The Council, after a long discussion, decided to adhere to their previous determination not to consent to the proposed new provisional order of the Reading Tramways Company, Limited, and that they were not prepared to give such consent upon any terms during the ensuing session of Parliament.

PROVISIONAL PATENTS, 1896.

DECEMBER 14.

28562. **Improvements in electric motors for driving engines.** Isaac Tillman Dyer and Otto Bruno Reichelt, 89, Chancery-lane, London.

28573. **Improved method of and means for extinguishing the "arc" formed in large high-pressure electrical circuit interrupters or switches.** Leonard Andrews, 166, Fleet-street, London.

28575. **Improvements in and in connection with glasses, globes, chimneys, and the like for use with gas, oil, and electric light.** William Sharp, 68, Melody-road, East-hill, Wandsworth, London.

28578. **Improvements in the bonding of rails used for electrical railways or tramways.** Rookes Evelyn Bell Crompton, 55, Chancery-lane, London.

28609. **Improved electric device for showing the relation of oxygen and nitrogen in mines.** Leo Cohn, 111, Hatton-garden, London. (Complete specification.)

28610. **Improvements in electric signalling apparatus for firedamps.** Leo Cohn, 111, Hatton-garden, London. (Complete specification.)

28612. **Improvements in or relating to telephonic systems, and in apparatus employed therein.** Alfred Julius Boult, 111, Hatton-garden, London. (La Société Anonyme de Téléphone Privée, Belgium.)

DECEMBER 15.

28663. **Improvements in the method of and means for protecting electric or other lamps when placed in dangerous positions especially from explosive vapours or the like.** William Robert Harrison and Percy Tom Runton, 8, Quality court, Chancery-lane, London.

28678. **Certain improvements in pendants for gas, electric, oil, and other lights.** Harry Hateley, 128, Colmore-row, Birmingham.

28688. **Improvements in incandescence electric lampholders.** Gustav Byng, 73, St. Stephen's-road, Upton Park, London.

28704. **New and improved switches for electric currents** William Robert Rawlings and John Joseph Rawlings, 82, Gloucester-road, South Kensington, London.

28723. **Improvement in secondary batteries for electricity.** Johannes Schuil, 20, Gladsmuir-road, Whitehall-park, London.

28725. **Improvements in or connected with prepayment meters for gas or other fluid and electricity.** Wesley Webber, 4, South-street, Finsbury, London.

28736. **Improvements in direct-current dynamo-electric generators.** Reginald Belfield, 322, High Holborn, London. (Benjamin G. Lamme, United States.)

28761. **An improved electrical brake for vehicles.** Edwin Grosz, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

28764. **Improvements in apparatus for use in electrolysis, more especially intended for use in the electrolysis of zinc chloride.** Ferdinand Hurter and the United Alkali Company, Limited, 47, Lincoln's-inn fields, London.

DECEMBER 16.

28845. **Improvements in electrical apparatus for firing ordnance.** Francis Weldon, 2, Lancaster-place, Strand, London.

28851. **Improvements in electrical make-and-breaks.** Henry Harington Leigh, 22, Southampton-buildings, Chancery-lane, London (Charles Milde, Sons, and Co., France.)

28884. **A system of electric distribution for combined lighting and traction plants.** Alexander Bewicke Blackburn and Wilfrid L. Spence, 47, Lincoln's-inn fields, London.

SPECIFICATIONS PUBLISHED.

1895.

23137. **Manufacture or production electrolytically of coatings composed of oxides of the earth metals.** Langhans.

1896.

135. **Method for the adjustment of carbons in electric arc lamps.** Fabris.

1401. **Electrical gas-reaction apparatus.** Naville, Guye, and Guye.

1574 **Electricity meters.** Siemens Bros. and Co., Limited, and Nebel.

1782. **Apparatus for testing magnetic quality.** Ewing.

2106. **Lightning dischargers for electrical installations.** Siemens Bros. and Co, Limited. (Siemens and Halske.)

2161. **Apparatus for conveying electric current from overhead conductors to motors on tramcars or like vehicles.** Dawson.

7254. **Electric igniting devices for gas-burners.** Krieger.

19822. **Automatic circuit breakers.** The British Thomson-Houston Company, Limited (Hewlett.)

20984. **Electric brakes.** The British Thomson-Houston Company, Limited. (Macdonald.)

21614. **Cut-outs and similar devices for electric circuits** Von Wurstemberger.

22127. **Electric locomotives.** Lake. (Warfield.)

23393. **Portable telephone apparatus.** Kandt. (Töpffer and Schädel.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	7⅞ 8⅛
Brush Company, Ordinary	3	¾-1
—— Non. Cum., 6 per cent. Pref.	2	1-1¼
—— 4½ per cent. Debenture Stock	100	110-113
—— 4½ per cent. 2nd Debenture Stock	100	96-100
Central London Railway, Ordinary	10	9¾-10¼
——	4	3⅞-4⅛
Charing Cross and Strand	5	9¼ 9¾
Chelsea Electricity Company	5	8¼-8¾
—— 4½ per cent. Debentures	100	114-117
City of London, Ordinary	10	15½-16½
—— 6 per cent. Cumulative Pref.	10	16½-17½
—— 5 per cent. Debenture Stock	100	128-133
City and South London Railway, Consolidated Ordinary	100	53-55
—— 4 per cent. Debenture Stock	100	136 138
—— 5 per cent. Pref. Shares	10	15¼-15¾
County of London and Brush Provincial Co., Ordinary	10	8-9
—— 6 per cent. Cum. Pref.	10	13¾-14¼
—— 4½ per cent. 2nd Debenture Stock	5	7½-8½
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1¾ 2¼
—— 5 per cent. Debentures	—	95-100
Edison and Swan United Ordinary	3	1¾-2¼
—— 5 per cent. Debentures	5	3-4
—— 4½ per cent. Debentures	100	103-106
Electric Construction, Limited	2	1⅜ 1⅝
—— 7 per cent. Cumulative Pref.	2	2½-3
Elmore's Copper Depositing	2	⅜-⅝
Elmore's Wire Company	2	¼-½
W. T. Henley's Telegraph Works, Ordinary	10	17½-18½
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	109-114
House-to-House Company, Ordinary	5	4½-5
—— 7 per cent. Preference	5	8½-9
India Rubber and Gutta Percha Works	10	20½-21½
—— 4½ per cent. Debentures	100	105-108
Kensington and Knightsbridge Ordinary	5	10-10½
—— 6 per cent. Pref.	5	8¼-8¾
London Electric Supply	5	1-1¼
Metropolitan Electric Supply	10	13-14
—— 4½ per cent. First Mortgage Debenture Stock	100	121-124
National Telephone, Ordinary	5	7⅛ 7⅜
—— 6 per cent. Cum. First Pref.	10	17-19
—— 6 per cent. Cum. Second Pref.	10	17-19
—— 5 per cent. Non. Cum. Third Pref.	5	6⅝ 6⅞
—— 3½ per cent. Deb. Stock	100	105-108
Notting Hill Company	10	10-11
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8½-9
—— £4½ shares	4½	7½-8
Oriental Telephone and Electric Company	1	11/16-13/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	103-105
Southampton Electric Company	5	4¾-5¼
St. James's and Pall Mall, Ordinary	5	12-13
—— 7 per cent. Pref.	5	9½-10½
Telegraph Construction and Maintenance	12	39-42
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	6	7¾-8¼
Westminster Electric Supply, Ordinary	5	11-12
Yorkshire House-to-House	5	7½-8

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